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The international transference of technology on an enterprise-to-enterprise base: A conceptual model and an application - A Brazilian experience in computers.

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THE INTERNATIONAL TRANSFERENCE OF TECHNOLOGY ON AN ENTERPRISE-TO-ENTERPRISE BASE: A CONCEPTUAL MODEL AND AN APPLICATION - A BRAZILIAN EXPERIENCE IN COMPUTERS

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To my parents,

Ceo and Riane.

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SUMMARY

This study is concerned with one of the most critical issues for developing countries today - the international technology transfer process. While there appears to be no concensus on what technology is, it seems widely recognized that technology is an essential factor in the industrialisation process. In recent years, some developing countries have become increasingly aware of the importance of technology, advocating the transference of technological resources, in an attempt to "leapfrog" the long period of technological evolution of the advanced nations, and accelerate their industrialisation process.

This research represents both a theoretical and an empirical attempt to understand the positive aspects of the technology transfer phenomenon. The major contributions of the study reported here are the following:

a) It proposes a broad conceptual framework for analyzing international technology transfer transactions on an enterprise-to-enterprise basis.

b) It clarifies the concepts of technology and technology transfer.

c) It describes the Brazilian pilot experience of transferring computer technology for the establishment of a computer production capability.

The results of this study suggest that the process of transferring tangible, intangible, proprietary and non-proprietary technological resources needed to establish an industrial production capability in another country is a dynamic, complex, multi-dimentional phenomenon, involving a variety of mutually interacting variables. These have been identified as contractual, individual, organizational, environmental, technological, transmission-mechanisms, resource-flow, and time-related variables.

In general, the technology transfer transaction was found to be an exchange of economic and technical interests between the technology-supplying and recipient organisations, in which individuals play a key role.

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1.1 INTRODUCTION

In recent years, there has been an increasing interest focussed on the study of technology transfer between industrialized and developing countries. While there appears to be no universal agreement on what technology is, or how it can be measured, at the same time, it seems widely recognized that technology is a key factor in the industrialisation process. As one study by the United Nations points out,

> "Technology has an essential role to play in reducing the disparities that exist between the developing and the developed countries. Computers are especially important in this context, because so many computer applications have a direct bearing on some of the main facets of the development process and reflect certain aspects of the technology that has facilitated the growth of the economically advanced countries" (United Nations, 1971:13).

This research is concerned with the process of transferring technology internationally. The concept of technology transfer is not new. Over two hundred years ago, Adam Smith seemed to recognize the socio-economic and political importance of what today would be called international transfer of technology. Within the context of the eighteenth century, he referred to the transmission, by the European colonists, of "Knowledge", "Skills", "Talents" and "Abilities", giving the colonies of European nations an opportunity to advance "... more rapidly to wealth and greatness than any other human society" (Smith, 1776:231).

Between the seventeenth and the eighteenth century, the manner through which the European industrial technologies were transmitted throughout the world had important implications in terms of subsequent industrialization and development. According to Furtado (1964) the expansion of European technology proceeded in the following directions:

1. Western European countries. The endogenous development and introduction of a series of inventions and manufacturing techniques transformed the socio- economic structure of these countries. In general, the technological variable not only changed the artisan economy of the mercantile system,

but also determined the development prospects of these economies.

2. The Colonies of Europe. The colonists who migrated to America, Australia and Canada transformed these regions into extensions of the European economies. Basically due to the transference of skills, and the relative abundance of natural resources, the colonies soon achieved relatively high levels of industrialization.

3. Other Regions of the World. As a result of the industrial development in maritime transportation and the expansion of international trade, some forms of European technology eventually reached other parts of the world. However, since the links between these regions and the technologically advanced economies were intermittent, and sometimes restricted to trading relationships, the spread of European technology among these parts of the world was uneven.

Presently, developing countries have become increasingly aware of the technological gap (Kuznets, 1972; OECD, 1968, 1970, 1981, Denison, 1967; Servan-Schreiber, 1968; Furtado, 1964, 1970) between them and the industrialized nations. According to a study prepared by the United Nations Conference on Trade and Development, (UNCTAD, 1979) in technologically dynamic, research intensive sectors, such as aircraft; space; electronics, petrochemical and chemical industries, the general technological gap between developed and developing countries is more intensified and considerably wide. The same study suggests that, in view of the rate of technological change in these sectors, the technological distance is likely to increase.

In the last decades, in an attempt to reduce the technological gap and to promote an accelerated industrialization process in developing countries, international organizations and Governments of less industrialized nations have dedicated considerable attention to the possibility of transferring technologies from the industrialized countries. (United Nations, 1971, 1972, 1973, 1975, 1978; OECD, 1974, 1975, 1981; Hawthorne, 1971; Jequier, 1976; Araujo, 1977, Germidis, 1977). Sometimes, reducing the technological gap is considered so critical for the extremely poor countries, that it virtually means the difference between starvation and prosperity.

(Livingstone, 1975) In general, the rationale for transferring technologies from abroad is presented as an attempt to "leapfrog" the long period of technological evolution of the advanced nations and spare the slow process of inventing things de integro. (Myrdal, 1981; Raju, 1973).

Traditionally, Brazil has been known as a commodity exporter. However, Brazil is now considered as the leading industrial producer in the Third World, mainly because of its extremely rapid economic growth during the last two decades. (OECD, 1979:214). Despite being characterized a "Newly Industrializing Country" for its shifts in the pattern of output and trade, Brazil is still modernizing through investments in basic industrial sectors of high technological content such as the electronics, capital goods, steel, metallurgical, chemical and petrochemical industries, which largely depend on the transmission of manufacturing, product and management technologies from abroad.

According to the development plans of the Brazilian Government, technology transfer was expected to play a key role in the modernization of the industrial structure of the country. In an attempt to transform Brazil into a developed nation in the period of one generation, The First National Development Plan

(1972-1974) considered technology as a critical factor for the country's industrialization process. (Brazil, Presidency of the Republic, 1971)

Among other things, the plan envisaged the implementation of a National Technological Policy, based on the acquisition of foreign technology for what Thomas (1977:183) calls "key sectors of technology such as aero-space and computers".

Regarding the computer sector, Brazil's total dependence on foreign computer technology, the observed growth in demand for computers, national policies, among other factors, led the Government to consider the creation of a digital minicomputer industry as a priority project for the industrial development of the country. In this context, the transfer of computer manufacturing technology was expected to play a pivotal role in the establishment of an indigenous computer industry. The Basic Plan for Scientific and Technological Development stated:

> "MINICOMPUTER INDUSTRY
>
> This project will result in the establishment in Brazil of a minicomputer industry through association of the Government with national firms and foreign manufacturers. This will

> permit the immediate transfer to Brazil of pioneering industrial technology, comprising a continuing flow of foreign technology that would be rapidly assimilated and absorbed." (Brazil, Presidency of the Republic, 1973:61)

The Government's strategy for the period 1975-1979, stated in the Second National Development Plan, utilized a similar approach regarding the acquisition of foreign technologies for the computer industry and other sectors of high technological content such as the chemical, steel, aeronautical and capital goods industries. In addition, the plan emphasized the need for absorbing, adapting, and creating technologies, so that, gradually the country's own technological capabilities would be developed.

1.2 DEFINITIONS AND SCOPE OF THE STUDY

The international technology transfer is an extremely broad and complex subject which can be studied from a technical, economic, cultural, educational, legal, managerial point of view and from many other perspectives and academic disciplines. The present research was intended to deal with two aspects of technology transfer. First, the multidisciplinary aspects of technology transfer, particularly the multiplicity of variables involved in the process of transferring technology from one place to another. Second, the managerial and regulatory policy issues posed by contractual arrangements for the transfer of technology. The scope of the study was restricted to the positive aspects of technology transfer and no attempt was made to deal with normative issues such as the adequacy of the technology in relation to the needs of the receiving country, etc.

A review of the literature indicated the lack of an adequate conceptual framework for analyzing the process of transferring technological resources internationally and a general lack of consensus concerning the concepts of technology and technology transfer. Many different interpretations and meanings were found to be associated with the notion of technology. The term originally used to designate an "art" or a "techna" in the contexts of the Greek and Latin cultures today has acquired wide connotations. Perhaps, reflecting the lack of agreement surrounding the meaning of technology, the expression "technology transfer" also means different things to theorists and users in various disciplines and field of activity.

For the purposes of this study, broad conceptions of technology and technology transfer were adopted, partially based on the United Nations' (1972,1979) definitions of the matter.

Technology was considered as an essential input for production, comprising tangible, intangible, proprietary and non-proprietary elements of technology in the form of capital and intermediary goods, human resources and information. In general, these elements of technology will be referred to as technological resources.

Technology Transfer was considered as the process by which one organization transmits to another the technological resources necessary for the manufacture of a product, the implementation of a process, or the rendering of a service.

Except where otherwise stated, the above definitions of technology and technology transfer will be utilized throughout this study.

1.3 OBJECTIVES OF THE RESEARCH

Considering the lack of an adequate theoretical framework for explaining the process by which technological resources are transferred from enterprises located in industrialized countries to enterprises in less- industrialized nations, the major objectives of this research are:

a) To provide a general theoretical framework for the study of international technology transfer transactions on an enterprise-to-enterprise basis.

b) To describe the Brazilian pilot experience of transferring computer technology for the establishment of a computer production capability.

Thus, this research represents an effort to make a theoretical and an empirical contribution to the current state of knowledge with respect to technology transfer. The first research objective attempts to combine a number of existing empirical observations and conceptual formulations into a comprehensive model for analyzing the factors and conditions which may affect the transmission of technology from a business enterprise to another. The second research objective attempts to develop a case study of technology transfer focussed on a specific sector of activity and industry. We have chosen to develop this case study within the context of a technologically dynamic industry and a Newly Industrializing Country. By concentrating on the Brazilian experience of transferring computer technology, it was believed that this would provide further insights into the rather unclear process of transferring technological resources across national borders.

1.4 STRUCTURE OF THE STUDY

This dissertation is presented in nine chapters, as follows:

CHAPTER 1 contains a general introduction to the research, and a statement of the objectives of the study.

CHAPTER 2 presents the conceptual overview of technology and technology transfer, identifies some channels and mechanisms for transferring various elements of technology, summarizes a number of factors presumed to influence the transfer process and presents the theoretical model which served to guide the empirical study to be presented in the remaining part of this dissertation.

CHAPTER 3 deals with the research design and methods utilized in this research, presents the hypotheses derived from the literature and the conceptual model, describes the sources of information and the procedure for the collection of data, provides operational definitions of the variables gathered through the interview guide, and discusses the methods employed for analyzing data and presenting the results.

CHAPTER 4 gives an idea of the Brazilian environment in the period 1970-1980, describes the evolution of the domestic and external economic sectors, discusses some conjunctural and structural aspects of the economy, and presents the regulatory framework on technology transfer transactions.

CHAPTER 5 provides an overview of the evolution of the computer market in Brazil in the period 1970-1980, presents some characteristics of the computer sector, and identifies the main institutional mechanisms for Government intervention.

CHAPTER 6 describes the development of events in Brazil, leading to the creation of COBRA, a tripartite joint-venture formed by the State, a local company and a foreign technology-supplier.

CHAPTER 7 analyzes the contractual arrangement between Cobra and the supplier of technology, and the mechanisms utilized for the transmission of technology. It includes an overview of the terms and conditions under which the technological resources have been transmitted, the forms of technology involved, the duration of the agreement, trade marks, information on technological improvements, training of human resources, technical assistance, rates of royalty and the settlement of disputes.

CHAPTER 8 presents the results obtained from testing the hypotheses related to the perceptions of factors affecting the transfer process held by both supplier and recipient.

CHAPTER 9 summarizes the conclusions derived from the previous chapters, presents the limitations of the research and suggests some areas for further study.

2. OVERVIEW OF THE LITERATURE

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2.1 INTRODUCTION

The major aim of this chapter is to establish a theoretical framework for analyzing the process of transferring technology internationally, on on an enterprise-to-enterprise basis.

The concepts of technology and technology transfer will be discussed in an attempt to derive operational definitions for the purpose of this research and to clarify the wide range of perceptions regarding the nature of technology and the transfer process. In addition, some channels and mechanisms for transferring various elements of technology will be identified, a list of factors presumed to influence the technology transfer process will be derived from the existing literature and will be integrated into a conceptual model.

2.2 THE CONCEPT OF TECHNOLOGY

The term technology, as it is known today, seems to have been another contribution of ancient Greece to western civilization. The etymology of the word technology suggests that the term derived from the

Greek language. According to a nineteenth century edition of Webster's dictionary, technology represented a combination of the Greek conception of "art" (τέχνη) and "discourse" (λόγος). Thus, technology primarily meant "a description of, or a treatise on the useful arts" (Webster, 1853: 1358). Webster also pointed out that the Greek word for art derives from the same root as that of the verbs to bring forth and to produce. An earlier translation of the adjective "technical" referred to the same Greek word root for art and described it as "belonging to the arts" (Johnson, 1778).

The meaning of "art" (ars) in the context of the Latin language was associated with skill, knowledge, artifice, cunning, trick, way or means, trade, business, and even the concepts of power and virtue. The notion of technique (techna) was referred to as "a craft" and as "a trick". (Entick, 1770). The term "technicus" (Technical) was described simply as a "vocabulum arti proprium". Webster's nineteenth century English description of the adjective technical was "of, or pertaining to, the useful or mechanic arts" (Webster, 1853: 1358)

The idea of the term "art" being semantically connected with the verb "to produce" may help to explain why later connotations of technology have been, sometimes, associated with industrial production activities. For instance, Adam Smith's "Inquire into the Nature and Causes of the Wealth of Nations" uses the expression "useful arts", perhaps to signify industrial manufacturing technologies, or the "mechanic arts". Commenting on the causes of the prosperity of the new colonies of Europe, in relation to other civilizations which did not have the advantages of acquiring various technologies through the immigration of European colonists, he stated:

> "The colony of a civilized nation which takes possession either of a waste country, or of one so thinly inhabited that the natives easily give place to the new settlers, advances more rapidly to wealth and greatness than any other human society. The colonies carry out with them a knowledge of agriculture and of other useful arts, superior to what can grow up of its own accord, in the course of many centuries, among savage and barbarous nations" (Smith, 1776:231).

Adam Smith's notion of technology is expressed under a variety of terms. He often referred to it as knowledge, arts, skills, talents, abilities, ingenuity, among other things. Specifically, he classed the "wealth" of a society under three categories, encompassing some forms of tangible and intangible technologies, as follows:

1. That reserved for immediate consumption, without any profit purposes, i.e. food, clothing, household furniture, etc.

2. That represented by the fixed capital of the society, used for the production of a revenue. This category was subdivided into four items:

2.1 Machines and instruments of labour. Perhaps, using a modern terminology these may be referred to as technology in the form of capital and intermediary goods. (United Nations, 1972). In general, these are examples of tangible, embodied or implicit technologies.

2.2 Buildings and edifices used for industrial purposes and providing a revenue for its proprietors.

2.3 Agricultural improvements of farms. Included in this item are the application of agricultural technologies which might improve the soil's productivity, and increase the revenue of the proprietors.

2.4 The abilities, talents and skills of the members of the society, acquired, at a cost by education, study or apprenticeship. Presently, these intangible "arts" are the object of know-how agreements in international markets for technology. They usually constitute the flow of explicit technologies among advanced and less industrialized nations, and in the literature are described as technologies in the form of human labour. (United Nations, 1972).

3. That represented by the circulating capital of the society. It consisted of money in circulation, raw materials, intermediate inputs and stocks.

The notion of technology as a special category of resource seems to have been stated by some of Adam Smith's followers in a variety of ways. Discussing the theory of comparative costs in foreign trade, David Ricardo used the terms "arts", "machinery", "knowledge" and "skills" to emphasize the technological variables in his analysis. One passage of the "Principles of Political Economy and Taxation" states:

> "Of two countries having precisely the same population, and the same quantity of land of equal fertility in cultivation, with the same knowledge too of agriculture, the prices of raw produce will be highest in that where the greater skill, and the better machinery is used in the manufacture of exportable commodities. The rate of profits will probably differ but little; for wages, or the real reward of the labourer, may be the same in both; but those wages, as well as raw produce, will be rated higher in money in that country, into which, from the advantages attending their skill and machinery, an abundance of money is imported in exchange for their goods". (Ricardo, 1817:123).

Alfred Marshall considered technology, or "knowledge", as the "most powerful" resource of production. Presenting his view on the classification of the agents of production, Marshall stated:

> "The agents of production are commonly

classed as Land, Labour and Capital. By Land is meant the material and the forces which Nature gives freely for man's aid, in land and water, in air and light and heat. By Labour is meant the economic work of man, whether with the hand or the head. By Capital is meant all stored-up provision for the production of material goods, and for the attainment of those benefits which are commonly reckoned as part of income. It is the main stock of wealth regarded as an agent of production rather than as a direct source of gratification. Capital consists in a great part of knowledge and organization: and of this some part is private property and other part is not. Knowledge is our most powerful engine of production; it enables us to subdue Nature and force her to satisfy our wants". (Marshall, 1890: 213).

More recent conceptualizations of technology also seem to include implicitly or explicitly, the notion of knowledge. For instance, according to John Galbraith, (1967:31) "Technology means the systematic application of scientific or other organized knowledge to practical tasks". Gruber and Marquis (1969:255) see technology as "the means or capacity to perform a particular activity" while Quinn (1969:148) defines it as "knowledge about physical relationships systematically applied to useful purposes". The United Nations Industrial Development Organization, suggests that technology or know-how is

> "The sum of knowledge, experience and skills necessary for manufacturing a product or products and for establishing an enterprise for this purpose". (UNIDO, 1973:1).

Pearlmutter (1976:12) notes three additional definitions of technology, mentioned by Contreras : (1975:5)

> "Technology may be defined as a set of instruments or tools, materials, know-how and abilities which are used to satisfy the community needs and to increase its control over the environment". (Herrera, 1973).

> "The ordered set of skills which is applied in the production and marketing of goods and services, and which is integrated not only by scientific knowledge coming from the natural, social and human sciences but also by empirical knowledge stemming from

observations, experience, certain abilities, tradition, etc. " (Sabato, 1972).

"Organized knowledge for production" (Sachs, 1973).

Some conceptions of technology seem to be increasingly associated with knowledge and software rather than machinery. For instance, assuming that the term technology is usually identified with its physical embodiments, such as hardware and other equipment, Doctors points out that this view is changing. He suggests that the intangible elements of technical knowledge such as techniques, managerial skills, information and computer programs are also being incorporated into the concept. As he puts it,

> "... we tend to view technology primarily in terms of machines and physical tools, that is, hardware. Increasingly, however, such software as systems concepts, management control techniques, and computer programs may all be viewed as being as much a part of the common store of technology as a rocket vehicle or a linear accelerator". (Doctors, 1969:3-4) .

A similar argument is put forward by Harvey Brooks. In addition, he suggests that technology should be viewed from a sociotechnical rather than technical perspective. He argues that:

> "It has been traditional to define technology in terms of its physical embodiments, as novel physical objects created by man to fulfill certain human purposes. In my opinion, this is too limited a view and one that is becoming increasingly obsolete ... technology must be sociotechnical rather than technical and a technology must include the managerial and social supporting systems necessary to apply it on a significant scale ... It seems to me that the defining feature of technology is that it is "public knowledge" in the sense proposed by J. M. Ziman (1968) with respect to science. But rather than knowledge of how and why things are as they are, it is knowledge of how to fulfill certain human purposes in a specifiable and reproducible way ... Technology therefore, does not consist of artifacts but of the public knowledge that underlies the artifacts and the way they can

> be used in society. Management, insofar as it can be described by fully specifiable rules, is thus a technology and indeed every large bureaucratic organization can be considered an embodiment of technology just as much as a piece of machinery" (Brooks, 1981: 35-36).

Recognizing the wide variety of connotations associated with the term technology, Livingstone offers three alternative definitions of the matter as follows:

> "Technology consists of a patent or a group of patents and the relevant knowhow to use the patents. In this most precise of definitions it is something which can be specifically licensed"

> "More generally, and at a lower level it may simply be skills possessed by craftsmen or tradesmen"

> "The most general definition of all sees technology as basic education, combined with an attitude of mind which favours change both as inevitable and desirable" (Livingstone, 1975:116-117)

In 1971, the Department of Economic and Social Affairs of the United Nations defined technology simply as "the knowledge of the industrial arts". (United Nations, 1971:13). In the following year, the United Nations Conference on Trade and Development provided a comprehensive definition. It considered technology as "as essential input for production", (United Nations, 1972:5) which may be bought and sold in international markets, in the following forms:

a) Capital and Intermediary goods. These include machinery, parts, components, other production equipment, inputs, etc.

b) Human Labour. The various categories of semi-skilled, skilled and highly specialized manpower which may be used for operating the productive system.

c) Information. This includes proprietary and non-proprietary information such as specifications, drawings, process instructions, design standards, testing standards, maintenance and repair procedures, layout of production systems, etc.

It seems that one of the main features of the United Nations' definition was to reduce technology to a "commodity" with three dimensions. As such, it can be the object of transactions and analyses at its material, human and informative levels.

The Organization for Economic Co-operation and Development stresses the difficulty in finding an all-embracing definition for technology, since the term involves tangible and intangible elements such as machinery, processes, techniques, skills and information and even a "technology culture". The cultural aspects of technology, apparently less discussed in the literature on international transfers seem, nevertheless, important. The OECD study suggests that "it is on such a "culture that the proper functioning of a given technical system ultimately depends" (OECD, 1981:18). Considering the cultural dimension of technology, the OECD's study notes that technology may be defined as:

> "The use of knowledge by a given society at a given moment to resolve concrete problems facing its development, drawing mainly on the means at its disposal, in accordance with its culture and scale of values" (OECD, 1978).

However, this concept of technology places the use of knowledge in a wider sociological and anthropological perspective, beyond the scope of this research. The relationship between man, technology and the environment has been discussed by Childe, (1956) and the relationship between technology, man, society and cultural values has been analyzed by Goulet (1977).

A narrower view of technology, applied in industrial contexts was also provided by the OECD:

> "Technology means systematic knowledge for the manufacture of a product, for the application of a process or for rendering of a service, including any integrally associated managerial and marketing techniques". (OECD, 1981:18).

This notion of technology as a form of knowledge rather than hardware (Doctors, 1969; Brooks, 1981) emphasizes intangible elements of technology, (Gabriel, 1972) such as technical and managerial elements of knowledge incorporated in human resources and techniques. A similar view of technology was adopted in the draft Code of Conduct on the transfer of technology. (UNCTAD, 1979).

Wallender also conceptualizes technology as a type of knowledge. He defines technology as "the knowledge or know-how necessary for the productive functioning of an organization". (Wallender, 1979:97). Considering the various forms of technical knowledge needed to operate an industrial enterprise, based on Peno's (1975) previous research, Wallender suggests the following categorisation of technology in terms of knowledge:

1. General knowledge refers to society's common fund of knowledge, which may be publicly available through newspapers, books, academic literature, professional organizations, universities, etc.

2. Industry Specific Knowledge: Refers to the technical knowledge which is common to most firms within an industry. This type of knowledge is necessary for manufacturing a product or implementing a process which is generally known by the firms within the industry, i.e. in the computer industry, how to assemble peripherals.

3. System Specific Knowledge: Refers to the technical knowledge necessary to produce a specific product, or manage a process. For instance, how to manufacture computers designed for process control applications.

4. Firm Specific Knowledge: Refers to the unique technical knowledge possessed by a

firm within the industry. This special production process knowledge or know-how derives from the firm's own capabilities and often represents a competitive advantage over other firms, i.e. Ferranti's Uncommitted Logic Array microprocessor.

5. Ongoing Problem-Solving Capability: refers to the firm's acquired know-how derived from experience in solving production problems on a continuing basis.

Synthesizing the discussion on the concept of technology:

1. The wide variety of notions of technology seems to suggest that there is no conceptual agreement on the idea of technology. The term originally used to designate an "art" or a "techna", in the contexts of the Greek and Latin cultures, today has acquired many connotations. Perhaps, the notion of knowledge associated with many perceptions of technology is a common element between old and new conceptions and definitions.

2. For the purposes of this research, a broad concept of technology will be adopted.

Technology will be considered as "an essential input for production" (United Nations, 1972:5), comprising tangible, intangible, proprietary and non-proprietary elements of technological knowledge in the following forms:

a) CAPITAL AND INTERMEDIARY GOODS. These refer to technology embodied in technology-intensive goods such as computer equipment, peripherals, modules, hardware, etc.

b) HUMAN RESOURCES. These refer to technology incorporated as knowledge, experience, skills and know-how of engineering, technical, administrative, and managerial resources.

c) INFORMATION. This refers to scientific, engineering and managerial technology disembodied in data, programs documents, specifications, written testing procedures, standards, formulae, manufacturing instructions, product designs, lay-outs, etc.

2.3 THE CONCEPT OF TECHNOLOGY TRANSFER

Over two hundred years ago, Adam Smith seemed to have a relatively clear understanding of the economic importance of what today would be called, international transfer of technology. Within the context of the mercantile system of the eighteenth century, the expansion of international trade and the maritime revolution, Adam Smith stated in the Wealth of Nations:

> "The discovery of America, and that of a passage to the East Indies by the Cape of Good Hope, are the two greatest and most important events recorded in the history of mankind. Their consequences have already been great; but in the short period of between two and three centuries which has elapsed since these discoveries were made, it is impossible that the whole extent of their consequences can have been seen. By uniting in some measure, the most distant parts of the world, by enabling them to relieve one another's wants, to increase one another's enjoyments and to encourage one another's industry, their general tendency would seem

to be beneficial ... At the particular time when these discoveries were made, the superiority of force happened to be great on the side of the Europeans ... Hereafter, perhaps, ... the inhabitants of all the different quarters of the world may arrive at that equality of courage and force which, by inspiring mutual fear, can alone overawe the injustice of independent nations into some sort of respect for the rights of one another. But nothing seems more likely to establish this equality of force, than that mutual communication of knowledge, and of all sorts of improvements, which an extensive commerce from all countries to all countries naturally, or rather necessarily, carries along with it." (Smith, 1776:259).

Thus, for Adam Smith, the "mutual communications of knowledge and of all sorts of improvements" seemed to be a "natural consequence" of international trade between Europe and the colonies. The notion of technology transfer associated with the trade of commodities appears to refer to the transmission of technologies embodied in products. However, in another passage, he gives an example of transfer of technology embodied in human resources. Discussing the way in which different countries acquired the capability to manufacture certain products, such as silks, velvets and brocades, Adam Smith stated:

> "In 1310, nine hundred families were driven out of Lucca, of whom thirty-one retired to Venice, and offered to introduce there the silk manufacture. Their offer was accepted many privileges were conferred upon them, and they begun the manufacture with three hundred workmen". (Smith, 1776:166).

In today's terminology, the migration of technologists, carrying with them the technical and managerial knowledge necessary to organize manufacturing activities, is sometimes referred to as a "brain drain". (United Nations, 1972).

The Draft Code of Conduct on Transfer of Technology proposed by the Intergovernmental Group of Experts at the United Nations Conference on Trade and Development (UNCTAD V) considered transfer of technology in terms of a transaction occurring between parties, involving the transmittal of "systematic knowledge". The comprehensive definition adopted under the code was:

"The transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service and does not extend to the transactions involving the mere sale or the mere lease of goods.

Transfer of technology transactions are arrangements between parties involving transfer of technology, ... particularly in each of the following cases:

a) The assignment, sale and licensing of all forms of industrial property, except for trademarks, service names and trade names when they are not part of transfer of technology transactions;

b) The provision of know-how and technical expertise in the form of feasibility studies, plans, diagrams, models, instructions, guides, formulae, basic or detailed engineering designs, specifications and equipment for training, services involving technical advisory and managerial personnel, and personnel training;

c) The provision of technological knowledge necessary for the installation, operation and functioning of plant and equipment, and turn-key projects;

d) The provision of technological knowledge necessary to acquire, install and use machinery, equipment, itermediate goods and/or raw materials which have been acquired by purchase, lease or other means;

e) The provision of technological contents of industrial and technical contents of industrial and technical co-operation arrangements". (UNCTAD, 1979: 3-4).

Edgar Hardy considers technology transfer a misleading expression. As he puts it, "The image of moving on transferring something from one area to another is totally erroneous. It is more like supplying a piece to an intricate and difficult puzzle or supplying the seed from which a tree may grow". (Hardy, 1974:187). He sees technology transfer as "a special case of the human communication problem", and defines it as "Communication for innovation between areas or organizations with different specific objectives". There seems to be two points in this definition which are not found in most views on technology transfer. First, in relation to the analogy between technology transfer and the communication act. Since both processes involve a sender, a message or the technology, a medium and a recipient, the analogy appears to be reasonable. Second, in relation to the specific objectives of the organizations involved in the technological transaction. Assuming that the transferring and recipient organizations may have different objectives, this seems to be an important variable in the relationship between the parties.

Recognizing the difficulties involved in finding a precise definition for the expression technology transfer, a study prepared by Cooper and Sercovitch for the United Nations Conference on Trade and Development, proposed that:

> "The transfer of technology from advanced to developing countries may be taken to cover the transfer of those elements of technical knowledge which are normally required in setting up and in operating new production facilities or in extending existing ones - and which are characteristically in very short supply (and often totally absent) in the developing countries" (Cooper and

Sercovitch, 1971:6).

The elements of technical knowledge included in this concept of technology transfer were classed into two groups, as follows:

1. Those needed in the pre-investment and construction stage, such as:

1.1 For the elaboration of market and economic feasibility studies;

1.2 For the determination and selection of the manufacturing technologies;

1.3 For engineering design of production facilities and the selection of equipment;

1.4 For constructing the plant and installing the equipment;

1.5 For the specification of the manufacturing process.

2. Those needed in the operation stage such as;

2.1 For technical and managerial operation of the enterprise;

2.2 For marketing the products;

2.3 For improving the efficiency of the production processes by minor innovations.

Based on Cooper and Sercovitch's view of the mix of technological resources needed in designing, constructing and operating production facilities, a United Nations (1972:5) study redefined the following elements of technology associated with the transfer of technology for industrial projects from developed to developing countries:

a) Feasibility studies, market surveys and other pre-investment services;

b) Determination of the range of technologies and the choice of technology;

c) Industrial processes;

d) Engineering design and detailed engineering;

e) Plant construction and installation;

f) Training of technical and managerial personnel;

g) Management and operation of production facilities;

h) Marketing information;

i) Improvements to processes and product designs.

According to Mansfield, (1971:110-115) technological improvements of products and processes may be expanded into the following elements of technical and managerial knowledge:

a. For developing applied research;

b. For preparing technical specifications of project requirements;

c. For designing the pilot-plant or prototype, testing and constructing;

d. For planning of production activities, construction of the plant and facilities;

e. For organizing the resources for manufacturing start-up;

f. For establishing the marketing start-up.

The above elements of technical and managerial knowledge seem to cover a wide spectrum of technologies involved in the evaluation, construction and operation of industrial plants. However, there seems to be another element of knowledge particularly needed in the initial stage of aquisition of technologies by industrial enterprises in developing countries. This element will be called "Experience of Technological Transactions". It refers to the combination of technical, legal and managerial knowledge accumulated during previous technological transactions by the organization. It involves an awareness of the complexities of the technology transfer process and an understanding of the implications of the contractual agreement. Assuming that the terms and conditions under which technological resources are acquired and the way they are transmitted have broader implications for the subsequent development of the enterprise, this appears to be a relevant variable.

To Samuel Doctors, technology transfer is:

> "The process whereby technical information originating in one institutional setting is adopted for use in another institutional setting. The transfer typically requires active participation by both the transferor and the transferee and implies more than the mere dissemination of technical information;

it implies the adaptation of new technology through a creative transformation and application". (Doctors, 1969: 3).

This definition of technology transfer emphasizes the active participation of the transferor and transferee in the process, as well the adaptation of the techniques to the new institutional environment. Although Doctor's study focussed on the programmes of the National Aeronautics and Space Administration, (NASA) his definition of technology transfer seems to be broad enough to cover some forms of international technology transfer. His analysis of NASA's technology transfer programmes indicated that computer manufacturers were those who benefitted most from "spin-offs" of military, space and nuclear technologies developed by the United States government.

The United Nations Industrial Development Organization points out that the transfer of technology between advanced and developing countries is different from that between organizations in industrialized countries. Rather than acquiring merely a licence or patent rights to manufacture for certain products developing countries usually depend on the transfer of "composite technology", or the sum of technological knowledge, know-how and expertise needed for setting up and operating an industrial enterprise.

A study published by the Organization of Economic Co-operation and Development (1981) cited Harvey Brook's view of technology transfer as "the process" by which science and technology are diffused throughout human activity". According to Brooks, technology transfer occurs when "systematic rational knowledge developed by one group or institution is embodied in a way of doing things by other institutions or groups ..." (Brooks, 1966). According to a Brooks' (1981) recent publication, certain technologies such as computers and communications carry along with them the managerial and social supporting systems. Thus, if this assumption is correct, the application of computer systems by developing countries is likely to involve the adoption of a modus operandi, since "not only the software, but the organization that goes with the system are inseparable from the physical embodiment of the technology..." (Brooks, 1981:36).

Based on Brooks' perception of the technology transfer process, the OECD study suggests that "the transfer concept concerns the enrichment of any given field through an input from outside." and proposes that "transfer consists of the operation whereby knowledge is diffused" (OECD, 1981:19).

Wallender adopted a definition of the Fund for Multinational Management Education (1978) which states that technology is transferred "when technology is transmitted, received, and applied". Wallender emphasizes that the technology transfer process involves a linkage between the transferor and the transferee and suggests that the transfer of managerial technology is "a change in the ability to manage the productive functioning of an enterprise". (Wallender, 1979:28). In other words, by equating the transfer of managerial knowledge to a change in the behaviour of the recipient, he seems to suggest, implicitly, that the transmission of managerial knowledge is similar to a learning process. (Boulding, 1966).

Summing up the discussion on the concept of technology transfer, the following points emerged:

1. Perhaps reflecting the lack of consensus surrounding the meaning on technology, there is also no universal definition of the expression technology transfer. Thus, it means different things to theorists and users in various disciplines and fields of activity.

2. For the purposes of this research

technology transfer refers to the process by which one organization transmits to another the technological resources necessary for the manufacture of a product, the implementation of a process, or the rendering of a service. Thus, it involves technological resources in the following forms:

a) Embodied in capital and intermediary goods.

b) Incorporated in individuals, such as those who possess technical and managerial know-how, skills and abilities.

c) Disembodied in information, instructions, specifications, designs, data, computer programs, etc.

2.4 CHANNELS AND MECHANISMS FOR TRANSFERENCE

According to the United Nations Conference on Trade and Development, (United Nations, 1972:8) there are several ways under which various elements of technical knowledge can be acquired from external sources. In general, technology can be obtained through one or a combination of the following methods:

a) The flow of books, journals and other published information;

b) The movement of persons from country to country;

c) Education and training of human resources;

d) Exchange of information and personnel through technical co-operation agreements;

e) Employment of foreign experts and consultancy arrangements;

f) Import of machinery and equipment and related literature;

g) License Agreements for the production processes, use of trademarks and patents, etc;

h) Direct foreign investment.

As the same study indicates, from the point of view of developing countries, the acquisition of various elements of technical knowledge through books (a) the movement of technologists, (b) training, (c) and the exchange of information and personnel (d) seems to involve less cost than the alternative sources (e) to (g). Apparently, some fairly simple non-proprietary manufacturing techniques and know-how may be obtained through contracting foreign experts. (e) (UNIDO, 1973) Some countries may import (f) directly from machinery suppliers, manufacturing technology embodied in capital goods such as petrochemical production equipment, and later discover that the know-how needed to operate chemical companies is only available in technologically advanced countries. (Cooper and Sercovitch, 1971) Licensing agreements, (g) franchising and management contracts are assuming increasing importance in the transference of proprietary and non-proprietary technologies to developing countries (United Nations, 1975; 1978; UNIDO, 1973; Brooke and Remmers, 1970). Foreign direct investment (h) is often cited as an important channel in the transmission of technical and managerial skills to less industrialized countries. (United Nations, 1975, 1978; Kindleberger; 1969, Baranson, 1970). Foreign Direct Investment by Multinational corporations, in particular, is mentioned as one of the most effective methods of transferring industrial and managerial technologies to less advanced countries. Multinational corporations can provide in a package form, advanced technology, capital, entrepreneurship and management. (Quinn, 1969; Baranson, 1978; Dunning, 1971, 1974, Behrmman and Wallender, 1976). On the other hand, some critics of the multinationals argue that they do not transfer technology at all; (Galeano, 1979) on the contrary they may attempt to limit the development of the local capabilities, (Santos, 1970) may use inappropriate technologies in relation to the factor endowments of the host countries, (Cooper, 1973) constitute a threat to national sovereignty (Vernon, 1971) and promote a state of continuous technological dependency of the peripheral countries on the central economies. (Furtado, 1964, 1970; Sunkel, 1969-1970, Evans, 1979).

Assuming that the degree of "packaging" of international transfer projects may have a positive correlation with the degree of foreign control, the United Nations (1972:11) suggested the following classification of enterprises, presumably arranged in a descending order of the degree of packaging:

a) Foreign branches (Extensions of the parent company operations in the host country);

b) Wholly-owned foreign subsidiaries (A joint stock company incorporated in the host country under local laws);

c) Foreign-controlled joint ventures;

d) Locally controlled joint ventures;

c) Local ventures with foreign contractual agreements;

f) Local ventures without foreign contractual agreements.

Cooper and Sercovitch describe a mechanism for transfering technology as "any means for making available to a production enterprise ... those elements of technical knowledge, which may be unavailable in the domestic economy, required to set up or operate production facilities " (Cooper and Sercovitch, 1971: 12). However, they suggest a distinction between the general supply of technical and scientific information and the specific transfer of technical and managerial knowledge needed to set up a particular production facility, as follows:

The general supply of technical information.

Refers to the common and informal ways in which general technical and Scientific knowledge may be acquired. These include:

a) Technical books, scientific newspapers, trade journals, sales literature;

b) Informal personal contacts and relationships;

c) Participation in professional conferences and meetings;

d) Participation in training programmes abroad, etc.

The specific transfer of technical knowledge. Refers to the transfer of technical, managerial and entrepreneurial knowledge needed inthe pre-investment, construction and operational stages of an industrial enterprise. These may include skills for the elaboration of feasibility studies, market research, design of production facilities, selection of process technologies, installation of the equipment, control of production, marketing of the output, etc.

Considering that the mix of technologies required to set up an industrial enterprise in a less industrialized country may be transferred in a number of ways and through a variety of channels, Cooper and Sercovitch proposed a classification of the mechanisms for transfer of technology. Based on the number of sources of technology the recipient may utilize for the acquisition of various elements of technological knowledge, they proposed the following categories of transfer mechanisms:

1. DIRECT TRANSFERS. The recipient enters into direct agreement with a number of different suppliers for the acquisition of the various technologies required for the establishment of production activities. Among the mechanisms for direct transfers are:

a) Contracting individual experts and consultant companies;

b) Engaging engineering design and plant construction enterprises;

c) Training nationals for specific production projects;

d) Technical Information Activities;

e) Importing process technology embodied in capital goods.

2. INDIRECT TRANSFERS. The recipient contracts only one supplier of technology, to provide the various elements of technology necessary to set up production facilities. The supplying organization, then contracts other suppliers of technical knowledge for the various activities and stages of the project. This is often referred to as "packaged" transfer, (United Nations, 1972) since the supplier may provide most of the elements of technical knowledge needed, from the feasibility study to the management of the enterprise in a single 'package'. Cooper and Sercovitch distinguish other modalities of indirect transfer mechanisms:

a) Investments in wholly-owned subsidiary enterprises. This is often considered one of the most important mechanisms for supplying technologies for less industrialized countries, (Baranson, 1969, 1970; 1978 Kindleberger, 1969; 1978; Behrman, 1962; Dunning, 1970; Behrman and Wallender, 1976). Sometimes, when the technological capabilities and the industrial infrastructure of the receiving countries are limited, this "may be the only mechanism through which the developing country can get access to contain kinds of technology, and perhaps the only means whereby some local resources can be exploited" (Cooper and Sercovitch, 1971: 34).

b) Licensing Agreements. These agreements, usually giving access to proprietary process technologies, may take a variety of configurations in the form of joint ventures, with varying degrees of equity participation in the recipient's capital structure. (United Nations, 1972; 1978; Balasubramanyam, 1973)

c) Turnkey agreements. These extreme forms of licensing agreements provide in a "package" the full range of tangible and intangible technological resources needed to establish an industrial enterprise. These agreements may involve proprietary and non-proprietary technologies. (UNIDO, 1973; United Nations 1972, 1975, 1978)

d) Other forms of contractual Agreements. Under this category are the management contracts, co-production agreements, contractual joint ventures and similar arrangements, (Gabriel, 1972, 1967; Brooke and Remmers, 1977) for the transmission of managerial, administrative and technological resources and capabilities.

3. DIRECT AND INDIRECT TRANSFERS. A combination of direct and indirect transfers occurs when a recipient acquires certain technologies directly from some suppliers and, at the same time, makes a contractual arrangement with one or more intermediaries to obtain indirectly, the remaining technological resources needed for the project.

Sometimes technology transfer is classed as a vertical or horizontal process. (Brooks, 1968; Mansfield, 1975, OECD, 1981).

VERTICAL TRANSFERS. Refer to the transfer of product or technical knowledge within a similar organizational environment. For instance, when a new technology is transferred from the research through development to the manufacturing division of an organization.

HORIZONTAL TRANSFERS. Refer to the transfer of product or technical knowledge between different fields of application, usually involving different organizations. For example, many developments of military and space projects of the United States Government, especially solid state electronics, computer and laser technology, now have been transferred to civil applications. (Brooks, 1972).

Recently, SRI International and Drexler Technology Corporation, of the United States, started to manufacture what is expected to be a major development in computer recording medium technology. Based on laser technology, they developed the "laser card", which is about the size of standard bank credit cards, and when recorded on both sides will be able to store forty million bits of data, some five million characters or approximately one million words of normal text. (Cane, 1982:11).

White (1974) provides four additional examples of horizontal transfers of technology, involving different types of institutions:

1. Corporation to Corporation. The

transference of transistor technology from Bell Laboratories to Texas Instruments. (1952-1954).

2. Government to Corporation. The transference of Jet Transport technology from the United States Government to the Boeing Corporation, (1952-1959).

3. Technical Institute to Corporation. The transference of Electrostatic Copy Technology from Battele to Halloid Xerox. (1977-1953).

4. University to Corporation. The transference of Electronic Digital Computer technology from the University of Pennsylvania to UNIVAC resulting in the subsequent establishment of the american computer industry (1946-1951).

According to White, the key variables in these successful cases of transfer of technology were:

a) Entrepreneurial initiative in the recipient organization;

b) Close personnel interaction between the transferror and transferee;

c) Technical knowledge of the recipient personnel;

d) Interactive joint efforts between recipient and supplier personnel over the years.

According to Mansfield, (1975) international transfer of technology between advanced and developing countries, sometimes involve both horizontal and vertical transfers, which might make it an extremely difficult process to manage.

The Organization for Economic Co-operation and Development makes a distinction between commercial and non-commercial transfers of technology. According to the OECD (1981) these two categories involve:

COMMERCIAL TRANSFERS. Based on the UNCTAD's Draft Code of Conduct on the Transfer of Technology, the OECD characterizes as commercial transfers of technology, the following technological transactions between two enterprises:

a) Assigning or granting of industrial rights;

b) Handing over technical or non-technical know-how in the form of documents, plans, diagrams;

c) The communication of technical or other know-how in the form of supply of services;

d) Providing a combination of services with a view to commissioning an industrial complex;

e) Providing technical services related to the selling or leasing of machinery.

NON-COMMERCIAL TRANSFERS. These include the multilateral and bilateral technological transactions between governments, agencies for international and national development, research institutions, universities, etc. According to the OECD, these are generally forms of co-operation between national authorities, designed to promote the host country's development, such as the provision of technical services for infrastructure projects and other governmental scientific, military, agricultural services.

Hertz (1980) suggests six alternative methods of transferring technological resources for the establishment of computer manufacturing activities between advanced and less industrialized countries, as follows:

1. The purchase of technologies directly from the suppliers. In his view, this method was widely used by Japanese firms when they acquired computer technologies directly from the United States and European manufacturers.

2. Licencing of technologies. Considering that enterprises in less developed countries usually lack the necessary technical and administrative infrastructure, Hertz argues that this method may not be an adequate solution for developing countries. According to the OECD (1969) several computer firms outside the United States, such as AEG-Telefunken, Mitsubishi, Olivetti-GE, Siemens and others, have acquired some computer technology through patent and manufacturing/licensing agreements. Ferranti, ICL, Fujitstu, Phillips and others, were some of the few companies without a manufacturing licence.

3. Foreign Direct Investments. Hertz posits that, in relation to technology transfer, the

success of this method depends, among other things, on a clear understanding of the objectives of the supplying and recipient organizations.

4. Donation of Technology. As Hertz has put it, although this method may be used among educational and health institutions, it seems improbable for firms operating in the highly competitive markets of the computer industry. (Dawson, 1975; Withington, 1975; Pantages, 1976; Lee, 1971; Szuprowicz, 1978; EIU, 1979a).

5. Industrial Espionage. According to Hertz, this method of acquiring technology is practised in advanced countries among some firms operating in highly competitive markets. (Wiener, 1982)

6. Multinational Corporations. In his view, although these firms may have superior managerial technological, financial, material, marketing resources and capabilities, an effective transfer of resources seems to be dependent, among other things, on their long-term objectives.

(Fayerweather, 1969). Assuming that a mutual accommodation (Gabriel, 1972) between their long-term interests and those of the host-country governments may be found, Hertz argues that these corporations probably have the vital elements needed for successful transfers. (Baranson, 1978; Behrman, 1970; Dunning, 1974)

A relatively recent study by Bornstein and others (1981) included fourteen alternative methods of transferring technological resources between western and Eastern European countries, compiled by McMillan (1977) for hearings of the Joint Economic Committee of the United States Congress. The following different types of commercial and industrial co-operation arrangements were identified:

"1. Sale of equipment for complete production systems - Such as 'turnkey' plants (usually including technical assistance).

2. Licensing - Of patents, copyrights, and production know-how.

3. Franchising - Of trademarks and marketing know-how.

4. Licensing or franchising - With provision also for market-sharing and quality control.

5. Cooperative sourcing - This involves long-term agreements for purchases and sales between partners (especially exchanges of industrial raw materials and intermediate products).

6. Subcontracting - Under a short-term (e.g., renewed annually) agreement, the subcontractor, with existing facilities, makes a product to the specifications of the contractor, who often also supplies materials or components.

7. Sale of plant, equipment, and/or technology - Including 1-3 above, but with complete or partial repayment in resultant products.

8. Production contracting - This agreement provides for production, on a continuing basis to the partner's specifications, of intermediate or final goods to be incorporated into the partner's product or to be marketed by him. In contrast to (6) subcontracting, production contracting

involves some transfer of production capability, in the form of capital equipment and/or technology (through a license or technical assistance contract).

9. Coproduction - Usually on the basis of some shared technology and agreed specifications, the partners specialize in producing and then exchange components, so each makes the same final product for sale in his own market area. Usually the Eastern partner makes the simpler or more labour-intensive components and the Western partner the more complicated or capital-intensive parts.

10. Product specialization - The partners specialize in making end products and then exchange them so each has a full line for sale in his market area. In contrast to (5) cooperative sourcing, product specialization involves changes in existing end product lines.

11. Comarketing - The partners (a) divide up market areas for some products, (b) sell and service each other's products in their

respective market areas, and/or (c) sell jointly in third markets the products of one or both partners. In practice comarketing occurs together with other forms of industrial cooperation, like (4), (8), (9), and (19), or through (14), a separate joint venture marketing company.

12. Project cooperation - Often called 'joint tendering', this involves East-West cooperation in building plants, developing natural resources, and/or providing infrastructure facilities in third (usually less developed) countries. It is sometimes labeled 'tripartite' to acknowledge the participation of the host country.

13. Joint research and development (R & D) - The agreement provides for joint planning and conduct of R & D, and joint commercial rights to the resulting product or process technology.

14. Joint venture - For any of the above activities the partners form a special mixed company, ordinarily with joint equity participation, management and

risk-and-profit-sharing" (McMillan, 1977:1182)

2.5 THE INTERNATIONAL TECHNOLOGY TRANSFER PROCESS

This section intends to present some concepts concerning the nature of the process of transferring, internationally, technological resources, in an attempt to derive a set of variables which will be subsequentely integrated into a conceptual model.

In 1969, the Massachusetts Institute of Technology "Conference on The Human Factors in the Transfer of Technology" provided some insights into the process of transferring new technical information from one organization to another. Initially planned to concentrate on human factors presumed to influence the process, scientists, engineers, political scientists and sociologists, recognizing the complexity and multiplicity of variables affecting the transfer process, it later decided to publish the proceedings of the conference as "Factors in the Transfer of Technology".

This conference focussed its attention on the transfer of technology between organizations within the same country. A priori, there are various indications to assume that the process of transferring technology across national borders may be considerably more complex because of socio-economic, infrastructural, political, legal and other environmental differences. (Fayerweather, 1969; Seurat, 1976; Bass, 1974; Mansfield, 1975; Wallender, 1979, Brooke and Remmers, 1977). However since both national as well as international transfers of technology may involve flows of information, financial, human and material resources, there appears to be some common characteristics between the two processes. Because both national and international processes have some characteristics in common, it seems reasonable to draw some analogies between them, as long as the set of variables which distinguishes one from another, or the differentia, is kept in mind.

In general, the participants of the conference agreed that technology transfer was determined, among other things, by the interrelationship between technical, economic and human factors, and that "the mechanism of technological transfer is one of agents, not agencies; of the movement of people among establishments, rather than the routing of information through communication systems". (Burns, 1969: 12; Gruber and Marquis, 1969: 266) Hardy (1974) supports this view and emphasizes that individuals are the key to successful transfers of technology. A particular model developed at the conference focussed on the transfer process and proposed that the magnitude of the transfer was a function of:

a) The source organization

b) The nature of the item to be transferred

c) The structure of the channels for transference

d) The recipient organization (Gruber and Marquis, 1969: 7)

Other variables assumed to affect the individuals' willingness and ability to transfer technological resources between organizations included:

a) The individuals' training, education and experience.

b) The individuals' personality characteristics. Personality traits, need achievement level, (Maslow, 1943, 1954) emotional reactions, sentiments, etc.

c) The individuals' communication patterns. Personal communications, personal interactions, (Little, 1965) personal relationships, (Allen and Conney, 1973; Allen, 1973; Hertz, 1980; Bass, 1974), "coding schemes" (Allen, 1969), etc.

d) Organizational effects. Vested interests of the organizations involved, possible conflict of objectives between the supplying and recipient organizations. (United Nations, 1972; Fayerweather, 1969; Hertz, 1980; Gabriel, 1972). Resistance to change, etc.

e) The organization's mission orientation. The extent to which the organization assesses the desired effects, formulates objectives, designs the necessary activities, allocates resources, etc.

f) The organization's motivation in relation to competitive pressures, expected financial rewards, visibility of results and governmental influences.

Figure 2.1 presents a micro-economic model of the technology transfer process, put forward by Samuel Bar-Zakay (1972). According to the author, this model identifies the basic elements, as well as presumable activities and sequence of events of the technology transfer process. The above part of the semi-PERT diagram indicates the activities to be performed by the technology supplier, or donor, while the lower part denotes those of the recipient. In the center of the diagram are listed the activities which are expected to be developed by both the supplier and recipient, i.e. the recognition of a technology transfer opportunity, the establishment of viable contact, the formulation of the transfer project, the analysis of the project's cost effectiveness, the recruitment of human resources, the establishment of a pilot organization, the establishment of a full-scale operation and the evaluation of the results. In relation to these activities, Bar-Zakay argues that:

> "The probability of success of any technology transfer would increase if the donor and the recipient were to perform the activities or satisfy the requirements outlined above and below the horizontal centre line. Many individuals and organizations engaged in technology transfer are taking shortcuts (indicated by wide arrows) which often lead to unsuccessful transfers", (Bar-Zakay, 1972:3).

The model includes four conditional decision points, separating the four major stages of the process denominated as search, adaptation, implementation and

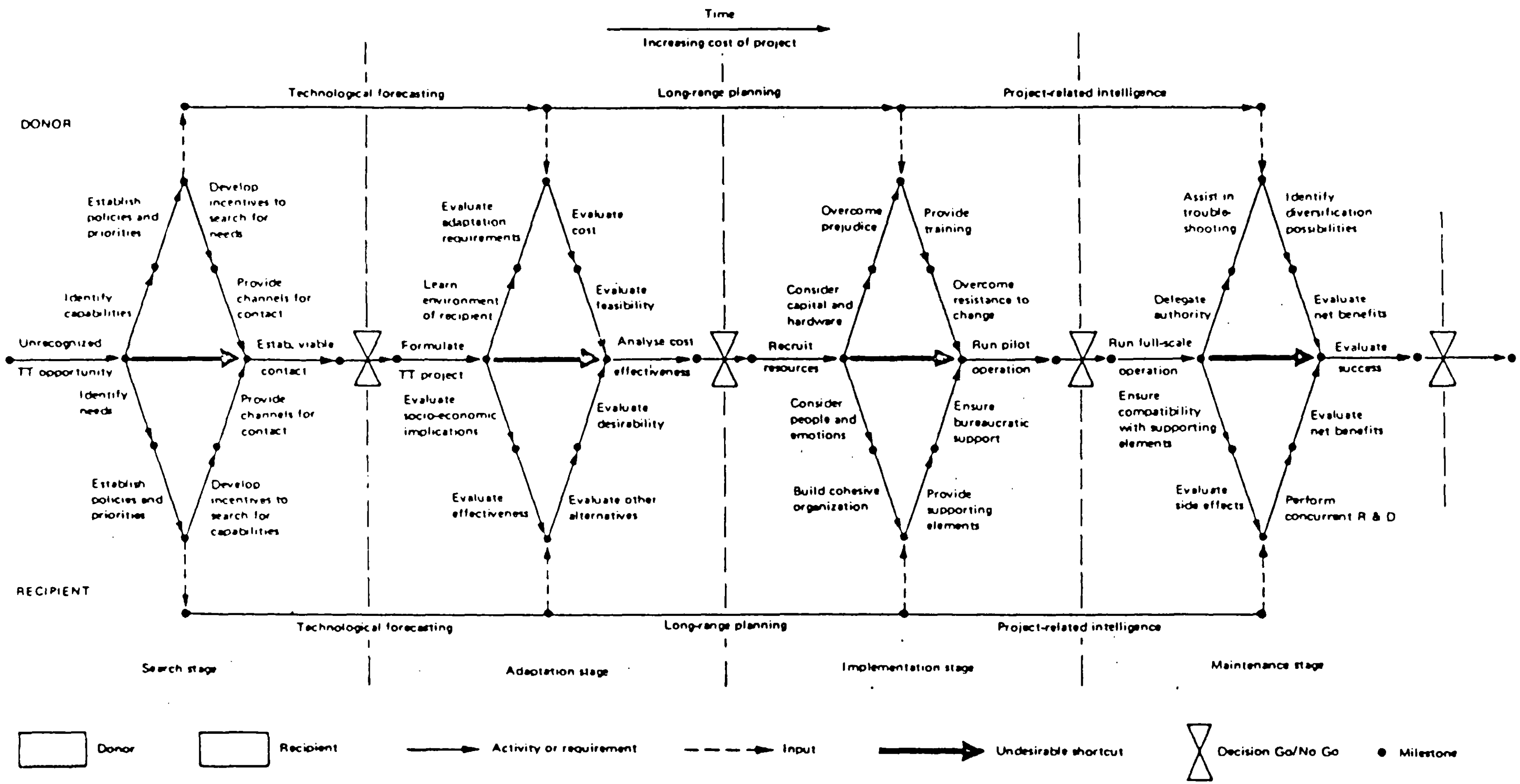


Figure 2.1 Bar-Zakay's Technology Transfer Model.

Source: (Bar-Zakay, 1972)

maintenance. At these points both the supplier and recipient decide whether the project should be terminated or continued, according to the inputs of previous activities and current circumstances. As indicated in the diagram, the cost and time of the project increase concurrently as the activities are executed. Other activities which should be carried out simultaneously by the supplier and recipient are designated as technological forecasting, long-range planning and project-related intelligence.

In relation to the applicability of the model, the author argues that "although there are differences in magnitude and relative importance, the forces involved in the process of technology transfer, are the same, irrespective of whether it takes place within a country or between countries". (Bar-Zakay, 1972:2). This assertion seems to suggest that national and international transfer of technology are basically identical processes, ignoring, among other things, fundamental differences that may exist between the transferring and recipient environments, such as culture, etc. Assuming that individuals are the main agents in the transmission of technological resources, (Burns, 1969; Allen, 1973; Knox, 1974; Geschka, 1974; Hardy, 1974) recognition of the cultural differences seems to be an important contextual variable in the international technology transfer process. (Bass, 1974; Chudson and Wells, 1974). According to Fayerweather, (1969;176) the communication problem between individuals from different nations, with no common social mores, values and other aspects of interpersonal relationships, is "a substantial obstacle distinct from the common problems of communication between different people within a single cultural group". As he points out, "an idea expressed by a manager which has a particular meaning in his cultural frame of reference may be received into the mind of a man from another culture with quite a different interpretation". (Fayerweather, 1969:175). Besides the problems of perception, (Baranson, 1969; Drucker, 1970; Gabriel, 1972;) there appear to be other economic, industrial, educational, legal, (Farmer and Richman, 1966) organizational and technical variables (Seurat, 1976; Wallender, 1979; Goulet, 1977; Baranson, 1969) which may add increased difficulties in the transmission of elements of technical knowledge from one country to another. (Mansfield, 1975; Rogers, 1972). Therefore, Bar-Zakay's contention that the technology transfer process is environment-independent and that the forces involved in national and international transfers "are the same" appears to be controversial.

Seurat's (1976) conceptual scheme of the technology transfer process is presented in Figure 2.2. According to his view, the major actors and variables of an international flow of technological resources are:

a) The socio-economic environment of the supplying and recipient organizations. Some of the main variables considered here are the country's economic structure, the scientific and technical infrastructure, the educational system, the cultural environment, national technical standards and measures, etc.

b) The supplying and recipient organizations. The important characteristics of the transferor and transferee's organizations, the nature of the production systems involved, the scale of the enterprise, the industrial and managerial background of the personnel, the degree of penetration and familiarity with the technologies and the level of manufacturing integration, defined as the percentage participation between the enterprise and sub-contractors.

c) The interested parties in the suppling and

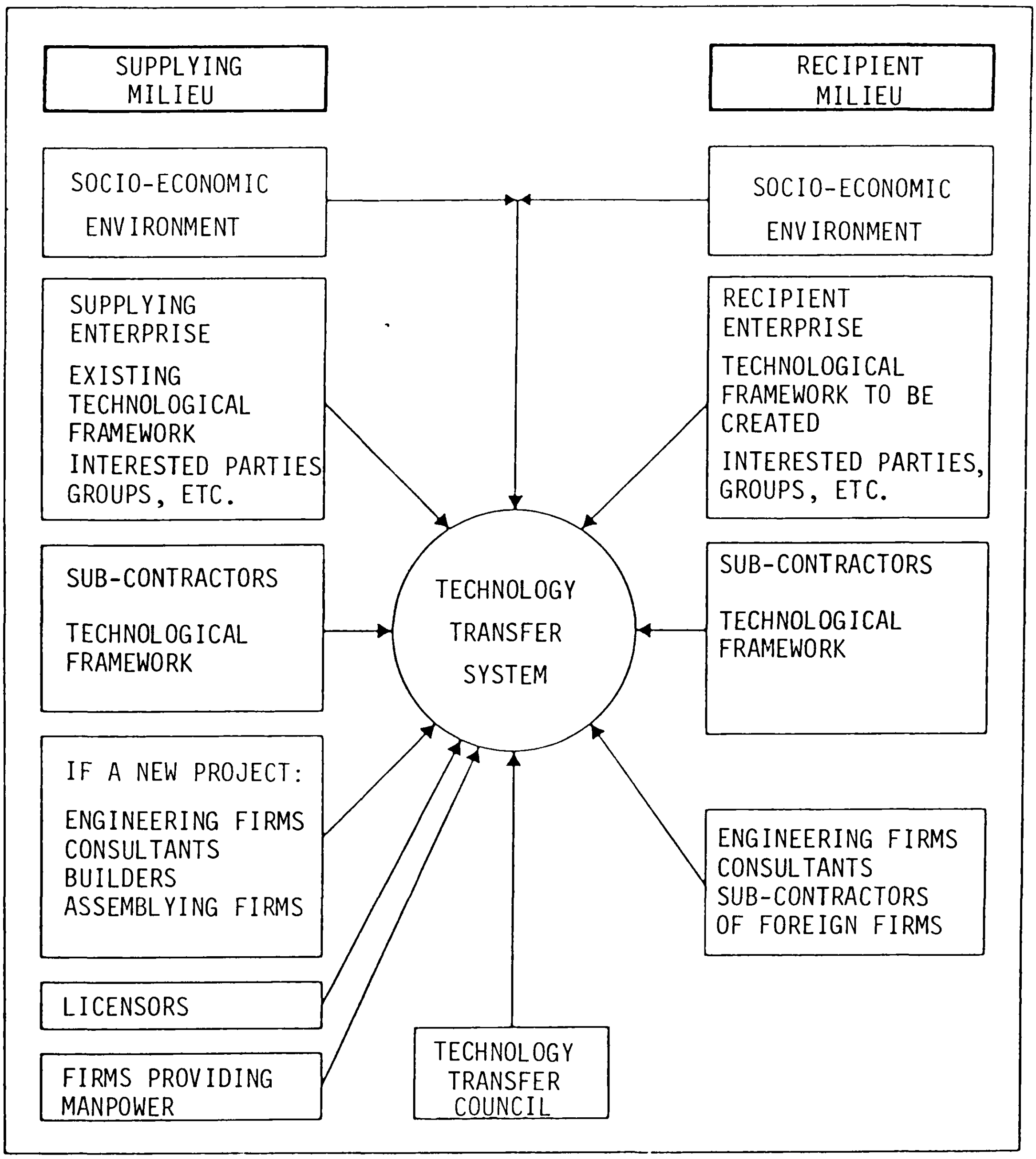


Figure 2.2 Relationship of actors in the Technology Transfer System.

Source: Seurat (1976)

recipient organizations. These parties can be a group, a division of the organization, a technical sector, etc., which will be directly involved with the object of the transference. The key factors considered are the administration of these sectors, an organizational "macro-structure" adapted to the degree of penetration of the techniques, a "micro-structure" with functions compatible with the culture and motivation of the individuals, the recruitment and subsequent development of personnel; group training, etc.

In Seurat's view depending on the complexity of the technologies involved, besides the actors listed above, other participants may join the transfer process. Sub-contractors, licensors civil engineering firms, assemblying contractors, etc., from the supplying and/or recipient countries may participate actively during the initial stages of the transfer process, supplementing elements of technical knowledge and physical resources needed, for the industrial project. A "technology Transfer Council" may also be established as an independent body in order to supervise the transfer activities between the parties.

According to Seurat this council performs a "technology transfer- engineering" function, dealing with the organization of resources needed for the transfer, rather than the set of techniques, and procedures. Among other things, the "Technology Transfer Council" may be responsible for the development of preliminary studies related to the situation of the supplier and recipient, the selection of personnel to act as "activators" of the process, the conception of the transfer system, the organization of tasks, the internal and external recruitment of manpower, the formation of individuals for particular roles, the training in group, the development of technical and managerial personnel, definition of criteria for measuring and evaluating the results , taking corrective actions, the development of the technology transfer plan, etc.

In relation to the presumed stages of the technology transfer process Seurat adopted a concept from Davous which distinguishes the following phases in the recipient organization for receipt of technology:

1. THE DIFFERENTIATION STAGE

This stage is characterized by the creation of a group of specialists with unique technological capabilities in relation to the other sectors of the organization.

2. THE INTEGRATION STAGE.

In this stage, there is a progressive absorption of unique technological capabilities by other members of the organizations.

3. THE DIFFUSION STAGE.

This stage is reached when the new technologies or skills are not restricted to a few specialists, but are diffused throughout the technical sectors of the organization.

Mansfield (1975) also emphasizes the importance of distinguishing between the various stages of the international technology transfer process. He suggests the following phases in the process of transferring tangible and intangible technological resources between industrialized and less industrialized countries:

1. MATERIAL TRANSFER STAGE. The export of material technologies, such as products or inputs for production, from one country to another.

2. DESIGN TRANSFER STAGE. The transfer of information, designs, blueprints, operational instructions, etc., necessary for the manufacture of products in the receiving country.

3. CAPACITY TRANSFER STAGE. Refers to the transfer of elements of technical knowledge needed to adapt the product or technological resources to the conditions of the environment. Apparently, this is the most difficult stage of the process, since it involves "learning of how to learn as well as to use what others have learned". (Mansfield, 1975: 373).

Behrman and Wallender's (1976) estimate the possible stages involved in the process of transferring technological resources from transnational corporations to wholly-owned subsidiaries located in less industrialized countries, as follows:

1. Proposal and planning of the project;

2. Product design;

3. Plant design and construction of the facilities;

4. Start-up of the industrial activities;

5. Value engineering and controls;

6. Product development;

7. External support activities.

Rubenstein (1974) has been studying the organization, management and economics of research and development in developing countries for approximately two decades. As a result of a project developed with the Organization of American States, (OAS) and previous research at the Massachusetts Institute of Technology and Northwestern University, he identified some general factors influencing the process of transferring tangible and intangible technological resources within and between organizations. The variables were:

1. Characteristics and behaviour of the source and user. Their attitudes, capabilities values, organizational position, communication style, education, past experience, etc.

2. Environmental factors. Governmental regulatory framework, geographic, financial, economic and market conditions, etc.

3. The nature of the interaction between the source and user. Personal relationships, liaison, trust, direct and indirect contacts, etc.

4. Technical factors. Characteristics of the technology, level of complexity in relation to the state of the art, its adaptability to local conditions, etc.

In a study focused on the transmission of technological resources to India, Balasubramanyam (1973) suggested that the key elements determining the success of transfer projects on an enterprise-to-enterprise basis were:

1. The willingness and ability of the supplying organization to transmit the mix of tecnhologies needed for the project. He argues that this factor seems to be closely related with the degree of ownership by the transferor. Apparently, there is a trade-off between the extent of technology transferred and the degree of capital ownership by the foreign partner. Thus, based on this argument, he suggests that the greater the complexity of the tecnhologies involved, the

greater the need for some form of capital control by the supplier. (Bredo, 1974) Presumably this allows a continous and close participation between the transferring and receiving organizations. In these cases, joint ventures and foreign direct investments seemed to offer better prospects for technology transfer than other modes of contractual agreements.

2. The absorptive capacity of the recipient organization to implement and/or adapt the technological resources to the local milieu. Balasubramanyam argues that the amount of resurces involved in implementing foreign technologies without substancial modifications is considerably smaller than that required for adapting them to the local environment. In his view, the investments and technological resources needed for adapting the technologies to the local conditions are usually beyond the capabilities of firms in developing countries. Thus, research and development activities needed in altering a product to the local conditions are more likely to occur

when the technology supplier has some degree of control of the recipient's capital structure.

Based on his experience in the Brazilian subsidiary of Burroughs corporation, one of the largest companies in the data processing industry of the United States (Barna, 1979), Hertz (1980) postulates the following list of variables influencing the process of transmitting technologies between organizations of industrialized and industrializing countries:

1. The nature of the technology;

2. Characteristics and objectives of the source and user organizations;

3. The transfer mechanism utilized;

4. Personal interactions between individuals of the supplying and recipient organizations. Hardy (1974), Burns (1969), Allen (1973), and Bass (1974) also consider this a key variable.

5. The technological infrastructure of the supplying and recipient countries;

6. Governmental policies and legislation

concerning technological transactions;

7. International commercial agreements involving the countries of the parties;

8. Political, economic, and market conditions.

In a study sponsored by the Fund for Multinational Management Education and focused on the transfer of managerial technology from industrially advanced countries to Brazil, Peru, Kenya, Korea and Tanzania, Wallender (1979) attempted to identify the major actors, factors and stages involved in the international technology transfer process. According to his view, the major actors of the process of transferring technology in the form of managerial knowledge, skills and expertise are:

1. The firm supplying the technology.

2. The environment of the supplier.

3. The firm receiving the technology.

4. The environment of the recipient.

Figure 2.3 illustrates the interaction of these actors in the transfer process. In general terms, Wallender suggests that the technology supplier becomes the transferring agent in the process. On the importance of analyzing the process of transferring elements of managerial knowledge between organizations situated in different environments taking into consideration all presumed participants or actors of the process, he states:

> "Intergovernmental discussions and research on technology transfer have not focused equal attention on all four actors and have been skewed toward the technology supplier and the technology user environment. Criteria for decisions made by suppliers to transfer technology have been examined in detail, theories on how supplier behaviour can impede or accelerate development in the Third World have been posited, and responsibilities of technology supplier (home) governments and user (host) governments in developing local technological capabilities have been articulated. For less attention, however, has been paid to the characteristics of the technology user. The result is that only one half of the transfer process has been examined. Initiatives undertaken by governments in both the developed and

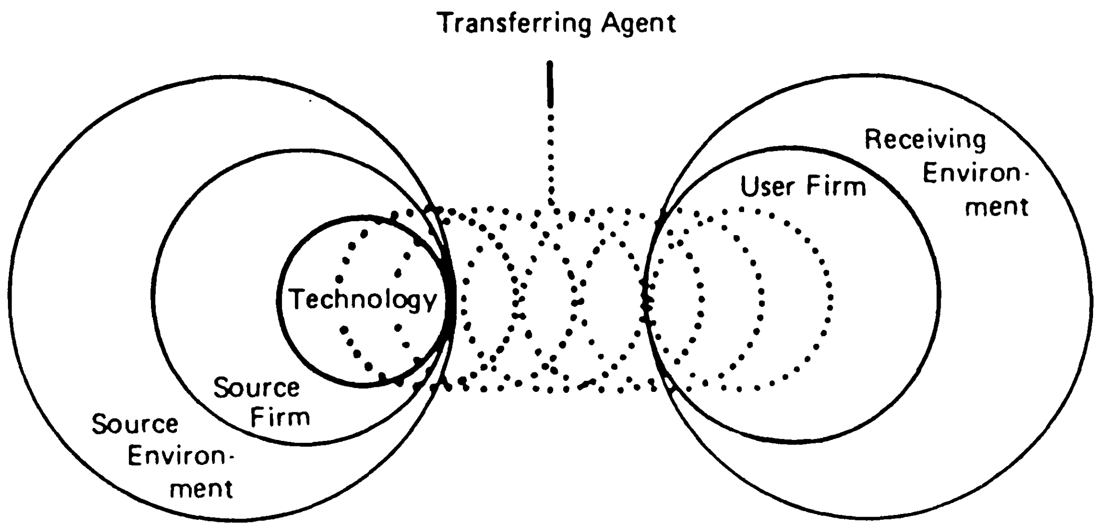


Figure 2.3 Interaction of actors in the Technology Transfer Process.

Source: (Wallender, 1979)

> developing countries to improve technology transfer and theories aimed at explaining technology transfer are characterized by a failure to examine adequately the traits of technology users and the conditions that affect their receipt and use of technology." (Wallender, 1979)

Regarding the stages of the recipient firm development for the acquisition, use and development of technologies, Wallender hypothesized eight cumulative stages presented in Table 2.1. These stages are grouped into four general phases denominated as organizational development, search for and acquisition of alternative technology, maintenance and modification of transferred technologies, and research, development and creation of unique technological capabilities, supposedly leading to the last stage of the process, or the capability of selling technology to other firms. Suggesting that the acquisition of a general management capability is a prerequisite for the subsequent stages of the recipient firm development for receipt of foreign technology, he argues that:

> "In any given environment, individual firms will be at varying levels of development in terms of their internal capabilities to

identify needs, search for technology, and exploit technology opportunities. Some developing country firms may have already developed the internal capability to receive and utilize foreign technology. Their immediate concern should be that of acquiring more information about alternative sources of technology. Most of the firms, however, will not have developed the general management capability to begin seeking much less acquiring or exploiting technology." (Wallender, 1979: 48).

Table 2.1 Stages of user firm development for receipt of Technology

---

ORGANIZATION DEVELOPMENT

1. Building the initial organizational structure (Management and initial technical assistance)

2. Developing an internal problem solving and diagnostic capability at the general management level.

SEARCH AND ACQUISITION

3. Searching for alternative technology after diagnosis and internal problem identification has been carried out.

4. Acquiring alternative technologies.

5. Transferring and exploiting specific technologies.

MAINTENANCE AND MODIFICATION

6. Maintaining and modifying technologies already transferred (product modification and system adaptation).

RESEARCH, DEVELOPMENT AND PRODUCT ENGINEERING

7. Developing unique internal technology capabilities (R & D and product engineering).

8. Exporting (sales) technology to other firms.

Source: (Wallender, 1979 : 48)

Concerning the factors presumed to affect the transfer of intangible elements of technology, Wallender suggested the following sets of variables:

1. Internal variables. The recipient firm's experience in technology acquisition, the organizational structure, the internal task technology, styles of leadership, the ownership of the enterprise, the strength of labour unions in the firm, the level of managerial, technical and manpower resources, availability of financial resources, perceptions of the value of technology and positive organizational myths.

2. External variables. Market characteristics (Wells, 1972; Vernon, 1966) and level of competition, governmental regulatory framework and policies, (Quinn, 1969), economic conditions, the degree of political stability, sources of supply, the country's technological (Stewart, 1977; Goulet 1977) and physical infrastructure, (Spencer and Woroniak, 1967) local support systems, and the cost and appropriateness of the technology. (Gupta, 1978).

From sixty seven projects analyzed in five countries, field researcher evaluations, and an additional four hundred and five volunteer responses from similar projects in various countries, the major conclusions of his study in relation to variables affecting the transmission of managerial technology seemed to be connected to internal factors. The lack of general managerial capability to recognize the value of the technology, the inability to establish long-term goals and the lack of management resources were considered major constraints at the user firm level. Other factors such as the ability to organize, external technological support, experience in the acquisition of technologies and market demand were assumed to have only a minor influence in the successful cases of technology transfer analyzed.

Assuming that an objective assessment of the organization's managerial marketing, technical, manufacturing, material and financial resources is a prerequisite for a successful transfer of technology, Bass suggests the following list of variables presumed to influence the process of transmitting technological resources from one organization to another:

"1. Receptivity of the Beneficiary. The organization to which the technology is transferred should be wholeheartedly favorable to its reception and should provide, to the best of its means, information about local requirements which have a bearing on its adaptation.

2. Dedication of the Transferer. The organization which transfers the technology should make every effort to transmit all information pertinent to the success of the operation in the local environment.

3. Mechanism of Transfer. The most effective transfer of technology occurs when there is very close interaction between the source and the recipient. For this reason, both parties should establish mechanisms to promote this face-to-face interrelationship by appointing congenial representatives with appropriate authority to enforce full cooperation.

4. Agreement Governing Transfer. All important aspects of the transfer should be spelled out in detail in the contractual documents, including arbitration procedures

for settling differences between the two parties.

5. Interim Review. A schedule should be established in the agreement for periodic joint review of performance by both parties in order that short-falls may be pointed out and corrected.

6. Competence of Recipient Organization. The parties should agree on the skills needed by the recipient to implement the transfer and the latter should take steps to acquire this internal expertise.

7. Termination of Transfer. There should be formal stipulation as to the conditions for relieving the donor of further responsibility and of vesting responsibility in the recipient for taking over the operation.

8. Continuing Relationship. After the transfer is completed to mutual satisfaction, there are usually further improvements by both parties. It is very desirable that cooperation should be continued to insure optimum benefit to the receiver.

9. Recognition of Cultural Differences. Both parties to the transfer should make best efforts to take into account the differences between the two cultures.." (Bass, 1974: 95).

From the preceding review of the literature on international technology transfer, the following points emerged:

1. There are some sparse but significant contributions to the literature towards an understanding of the international technology transfer process. At present, however, it appears that no conceptual scheme satisfactorily embraces the multiplicity of elements and variables involved in technology transfer, from organizations in industrialized countries to enterprises in industrially less-advanced nations.

2. The process of transferring technology in the form of capital and intermediary goods, information, human resources, elements of technical and managerial knowledge and know-how needed to establish an industrial production facility in a less industrialized country, seems to be a complex,

multi-dimentional phenomenon involving several actors and a variety of mutually interacting variables.

Based on the above assumptions, in the next section, an attempt will be made to develop a comprehensive conceptual model for analyzing the process of transferring technological resources internationally, on an enterprise-to-enterprise basis.

2.6 A CONCEPTUAL MODEL OF THE TRANSFER PROCESS

In this section, a conceptual model of the international technology transfer process is presented. The model derives from the review of the literature and attempts to integrate the major concepts discussed in the previous sections. Initially, a brief rationale for developing this model is presented.

In the social sciences the researcher is often confronted with complex, multi-disciplinary problems (Ansoff, 1977) involving a large number of variables, which sometimes are not amenable to quantification. Assuming that technology transfer is essentially a human activity, it involves what Abt (1968) has described as the "muddy" variables of attitudes, feelings and behaviour and their interaction with organizational, economic, political, cultural and technological variables.

Faced with the complexity and the wide range of variables which may affect the process of transferring technology internationally, and the lack of an adequate theoretical framework to guide this study, the researcher developed a conceptual model of the transfer process, in an attempt to provide a comprehensive theoretical framework for analyzing technology transfer transactions on an enterprise-to-enterprise basis.

Broadly speaking, a conceptual model represents an approach for investigating complex, real world problems or situations. It is based on the method of analogy, which is considered as one of the main methods of scientific inquiry (Ackoff, 1962). The construction of a conceptual model basically involves the setting up of a conceptual analogue of the subject matter, representing only the main features of the thing to be investigated. Thus, by reducing reality to more manageable proportions, the investigator might gain some insights into the complexities of the problem or situation being examined. As Kaplan has indicated,

> "Science always simplifies; its aim is not to reproduce the reality in all is complexity, but only to formulate what is essential for understanding, prediction, or control". (Kaplan, 1973:280).

OVERVIEW OF THE MODEL

The multiplicity of actors and variables identified in the review of the literature have been combined in an attempt to comprise a comprehensive model for explaining the process of transferring industrial technology internationally on an enterprise-to-enterprise basis.

Figure 2.4 presents the diagram of the general conceptual model and illustrates, schematically, the actors and interfaces in the transfer process. Technology transfer was conceptualized as an exchange process. The notion of exchange (Weber, 1947; Homans, 1950; Blau, 1958 ; Fayerweather,1969) involves a bargaining relationship between two parties. Thus, according to the exchange framework, the technology supplier provides the technological resources to the recipient in exchange for monetary or other resources. The main actors in the international transfer process have been identified as follows:

a) The individuals from the technology-supplying and recipient organizations;

b) The organizations supplying and receiving the technological resources;

c) The environments of the countries supplying and receiving the technology.

Figure 2.4 also displays three hierarchically related interfaces between the actors involved in the

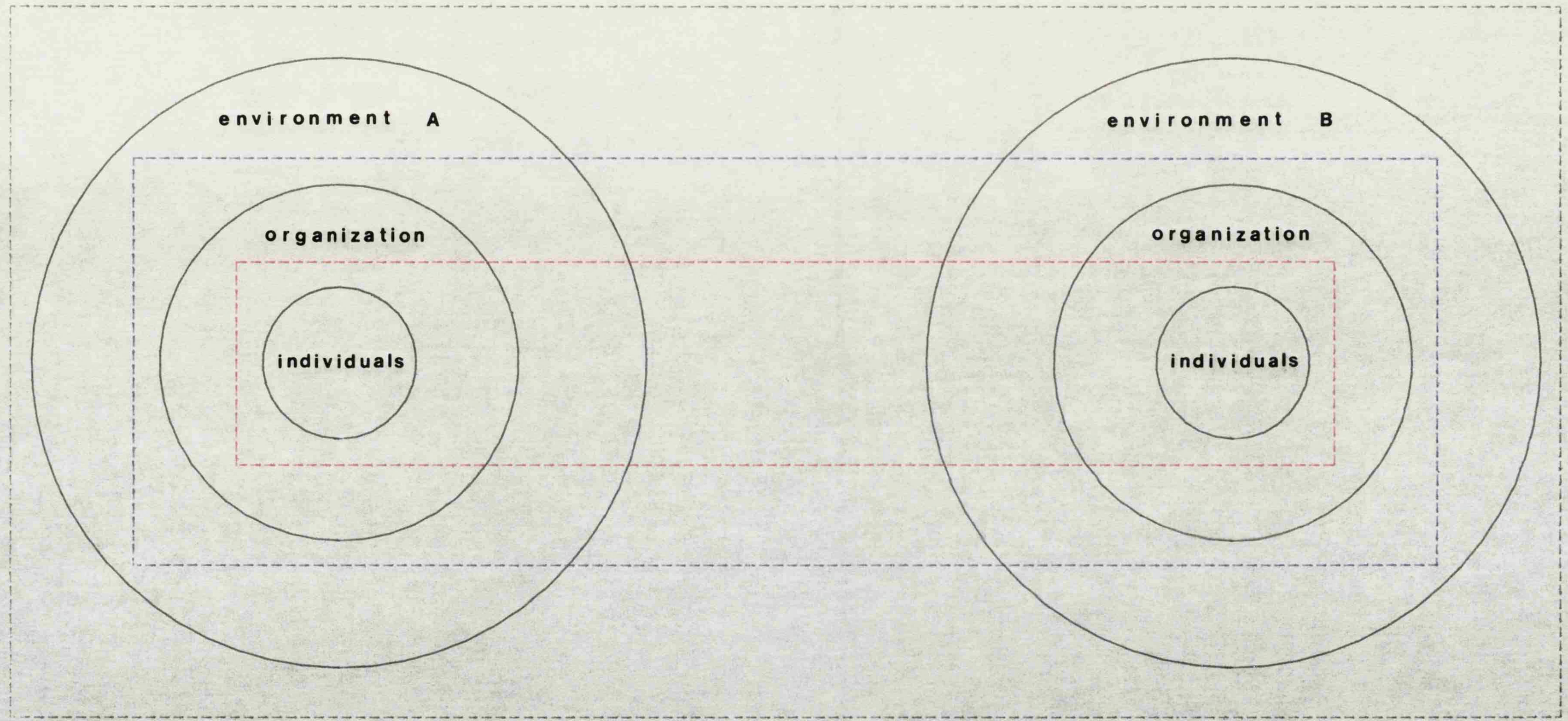


Figure **2.4** Diagram of the General Conceptual Framework

Main Actors and Interfaces in the Transfer Process

process. Assuming that a conceptual model represents a system; (Kaplan, 1973) and that a system is essentially "a complex of elements standing in interaction" (Bertalanffy, 1950) with its hierarchy of levels of subsystems, the three interfaces between the supplier and the recipient shown in figure 2.4 can also be conceptualized as subsystems of the total transfer system. Thus, from the highest to the lowest level of analysis, the following interfaces or subsystems can be distinguished:

a) THE ENVIRONMENTAL INTERFACE concerns itself with the interaction between the supplier and recipient's environments. Examples of relevant variables involved are the reciprocal economic agreements between the two countries, diplomatic relationships, special agreements on tax matters, legislation on the migration of human resources, governmental policies on the flow of industrial and defence technologies, import restrictions, etc.

b) THE ORGANIZATIONAL INTERFACE concerns itself with the interaction between the technology-supplying and recipient organizations. The conflict or congruence of interests between the objectives of the organizations, the degree of ownership and control involved, the pattern of intercommunication, the availability if resources, etc.

c) THE INDIVIDUAL INTERFACE concerns itself with the interaction between the individuals from the two organizations involved. The individuals' attitudes, behaviour, formal and informal relationships, communication patterns, etc.

ELEMENTS OF THE MODEL

The basic elements of the conceptual model of the technology transfer process are presented in figure 2.5. The major variables affecting the transfer process are defined as follows:

a) CONTRACTUAL VARIABLES. Refer to the set of variables related to the contractual agreement governing the transfer of resources between transferor and transferee. The terms and conditions under which various forms of technology will be transferred, duration of the contract, clauses pertaining to the use

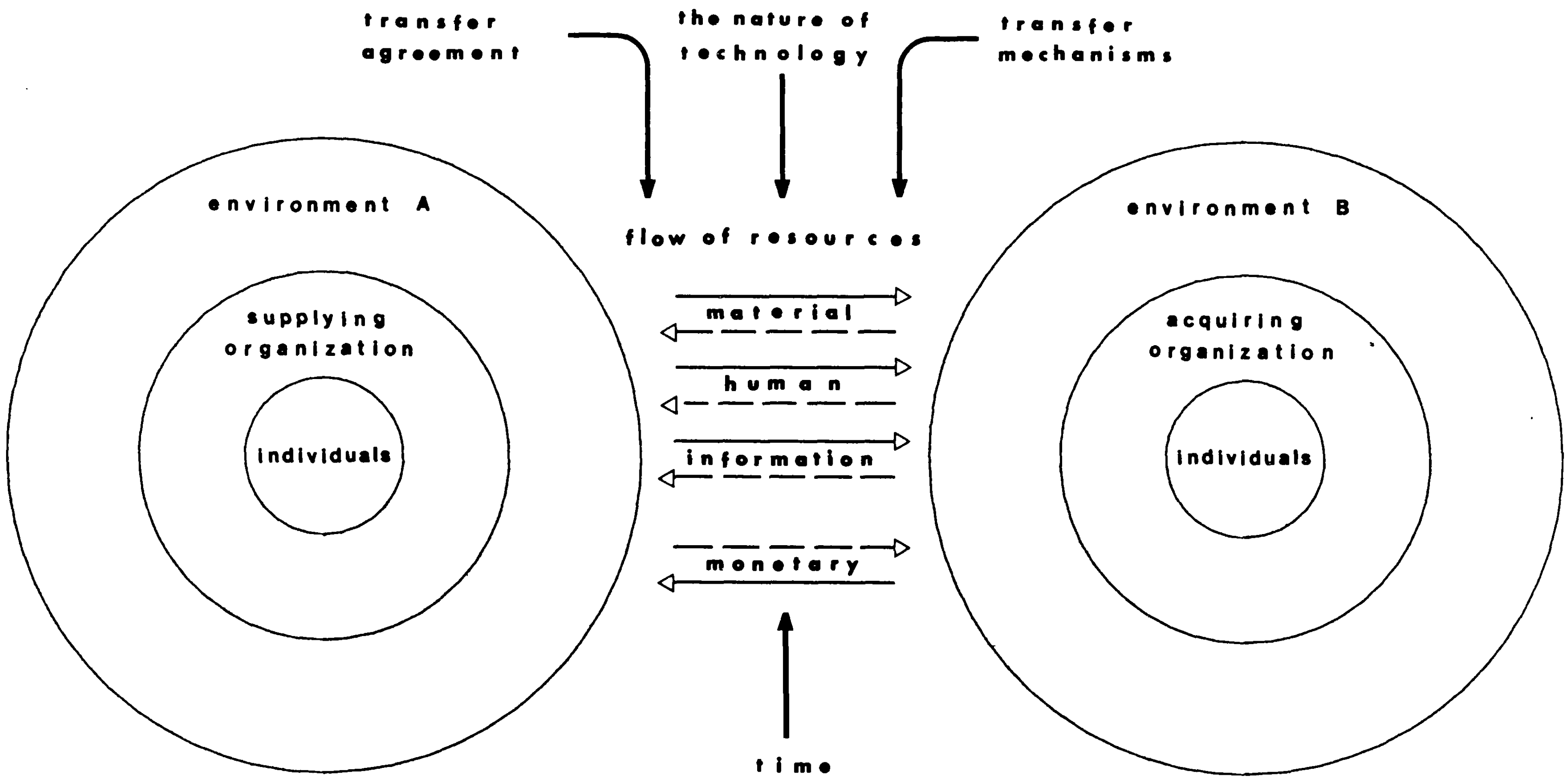


Figure 2.5 Diagram of the General Conceptual Framework

Main Actors and Flows of Resources in the Transfer Process of trade marks, rates of royalty, improvements on technological developments by the parties, training of personnel, technical assistance, the settlement of disputes, etc.

b) INDIVIDUAL VARIABLES. Refer to the characteristics and behaviour of the individuals from the supplying and recipient organizations. These include their formal education, training, previous experience in relation to the technologies involved, interests, motivations, capabilities, pattern of interactions, relationships, etc.

c) ORGANIZATIONAL VARIABLES. Refer to the characteristics and behaviour of the supplying and recipient organizations. The experience of technological transactions, familiarity with the technologies involved, the availability of financial material, technical managerial and manpower resources, organizational objectives, communication channels, the degree of technical and managerial control of the enterprise, the capital structure of the organization, structure of transfer activities, the scale of the enterprise, etc.

d) ENVIRONMENTAL VARIABLES. Refer to the economic, legal, political, cultural, educational and market environment of the transferring and receiving countries. The economic structure and conjuncture, governmental policies and legislation, the technological and physical infrastructure, the government regulatory framework concerning technology transfer, industrial market structure, cultural and educational characteristics, national standards and measures, etc.

e) TECHNOLOGICAL VARIABLES. Refer to the nature and characteristics of the technologies involved. The tangible intangible, proprietary and non-proprietary elements of technology, the complexity, and level of sophistication in relation to the state of the art, the relationship and dependence on related technologies, the rate of technological change, etc.

f) TRANSMISSION-MECHANISMS VARIABLES. Refer to the mechanisms, procedures and methods whereby the technological resources are transmitted from one organization to another.

Technical manuals, specifications, training courses, technical assistance, drawings, close personal relationships, etc.

g) RESOURCE-FLOW VARIABLES. Refer to the resources that are exchanged between the parties. These represent the object of the technology transfer transaction. From the recipient's point of view these are the flows of technology in the form of material, human and information resources, knowledge, skills, etc. From the supplier's point of view, except in barter transactions or similar arrangements, these are the payments for licences, the supply of products, technical assistance, etc. A further subdivision of technological resources can be distinguished.

1. Tangible Resources. Included in this category are those which can be physically transferred from one place to another, as follows:

1.1 Material Resources. Refer to capital and intermediary goods, etc.

1.2 Human Resources. Refer to the actual movement of human resources from one place to another, i.e. the migration of personnel.

1.3 Information. Refers to elements of technical knowledge disembodied in manuals, documentation, procedures, specifications, computer programs, etc.

2. Intangible Resources. Included in this category are those which can not be physically transferred from one place to another, but may be transmitted through learning processes, personal experience, training, etc. These are:

2.1 Knowledge, skills and abilities. Refer to the elements of Knowledge and capabilities required for:

a) Manufacturing an existing product or implementing a process and marketing the output;

b) Modifying an existing product or process and marketing the output;

c) Developing a new product or process and marketing the output.

h) THE TIME VARIABLE. Refers to the periods of time involved in the transmission of resources between the transferor and transferee.

In chapters 7 and 8 an attempt is made to test the conceptual model presented above , by taking the example of the Cobra-Ferranti experience in international technology transfer. Chapter 7 analyzes some aspects of the contractual agreement between the technology-supplying and recipient organizations, and the mechanisms utilized for the transmission of the technological resources involved in the transaction. Chapter 8 discusses four hypotheses related to the supplier and recipient's perceptions of individual, technological, organizational and environmental factors affecting the transfer process. In the next chapter, the methodology utilized for this study is discussed and a statement of the hypotheses is presented.

3. RESEARCH APPROACH AND METHODOLOGY

3. RESEARCH APPROACH AND METHODOLOGY

3.1 INTRODUCTION

In the previous chapter the literature on international technology transfer was reviewed, the concepts of technology and technology transfer were discussed and some mechanisms, actors and variables presumed to influence the process of transferring technological resources between organizations in countries at different levels of development were identified and integrated into a conceptual model.

The major objective of this chapter is to discuss the methodology utilized in this research. This chapter consists of six sections. Section 3.2 describes the research design and methods employed in this study. Section 3.3 presents the hypotheses derived from the review of the literature and the conceptual model. Section 3.4 presents the unit of analysis utilized for the study. Section 3.5 deals with the procedure for the collection of data and the selection of the respondents. Section 3.6 describes the methods utilized for analyzing data and presenting the results.

3.2 RESEARCH DESIGN AND METHODS

A review of the literature, presented in chapter 2, indicated that there is no agreement on what the concept of technology means, and suggested, at the same time, the existence of wide connotations associated with the expression "Technology Transfer". Thus, assuming that there exists no theoretical consensus on the concepts under investigation, this study adopted a combination of an exploratory and descriptive approach. According to Selltiz and his associates, (1976) the exploratory research approach attempts "to gain familiarity with the phenomenon and to achieve new insights into it ..." (Selltiz et al., 1976:90). The same authors suggest that the exploratory research design may be a useful strategy for:

a) Gaining a better understanding of a particular problem, process or situation;

b) Clarifying vague concepts for analysis;

c) Establishing priorities and information for subsequent studies;

d) Providing a collection of information on a particular phenonenon.

In view of the objectives of the research stated in section 1.3 and within the limitations imposed by the availability of research resources, the availability of time and subjects, the following methods of information gathering were used in this study:

1. REVIEW OF THE LITERATURE. The previous chapter indicated that the available literature on the positive aspects of the process by which technological resources are transmitted internationally is sparse. However, assuming that scientific explanations may be produced only when empirical and theoretical knowledge are used together, (Toulmin, 1953) the review of the literature was considered an essential stage in clarifying the concepts for analysis, unifying the theoretical framework, gaining theoretical awareness in general, and integrating the variables presumed to influence the transfer process into a conceptual model.

2. PERSONAL INTERVIEWS. These included both structured and unstructured interviews with executives, managers, engineers and

technicians of the technology-supplying and recipient organizations involved in the process of transferring computer manufacturing technology to Brazil. Additional information was gathered from interviews with individuals from Government agencies, universities, manufacturers of computer and peripheral equipment, professional associations and other organizations connected with the computer industry. Despite the problems of systematizing information derived from open discussions, the use of unstructured interviews and qualitative data (Schneider et al, 1980; Patton, 1980) provided illuminating details which, perhaps, otherwise would be lost. However, information gathered through personal interview is subjected to biases derived, among other things, from the investigator and subjects' personalities, attitudes and expectations. (Rosenthal, 1966; Phillips, 1973)

3. THE EXAMINATION OF DOCUMENTS. Information was supplemented by the examination of some internal documents, contractual agreements,

letters, technical data on the products and processes involved, and other written material provided by the technology-supplying and recipient organizations. It was assumed that the use of important documents could help to identify some non-malleable variables in the transfer process, such as the terms and conditions of the contractual agreement signed between the transferor and transferee, etc. Although the examination of significant documents apparently produced some insights into the process of transference, their use was limited, among other things, by the complexity of the problem being analyzed, the investigator's perception of the material, the representativeness of the data, the adequacy of the information, the reliability of the record and the validity of the interpretations of the researcher. (Angell and Freedman, 1953). In addition, some documents and data were collected from the National Institute of Industrial Propriety (INPI), the Central Bank of Brazil (BC), the Getulio Vargas Foundation (FGV), and other organizations representing a cross-section of the computer industry in Brazil.

4. CASE STUDY ANALYSIS. The analysis of the Ferranti-Cobra experience in international transfer of computer manufacturing technology was another method utilized in this research.

The case study analysis is basically "a depiction either of a phase or the totality of relevant experience of some selected datum" (Foreman, 1948: 408). The case study method, developed by the Havard Law School and adopted by Harvard Graduate School of Business Administration, has become widely used by social scientists in a variety of disciplines. (Chinoy, 1955; Argyris 1958; Udy, 1970) It involves, among other things, a detailed description or history of a problem or situation to be analyzed and discussed, (MacNair, 1954) sometimes emphasizing the time dimension. In general, the major goal of the case study approach is seeking insights and explanation. As Selltiz and his associates have argued,

> "Scientists working in relatively unformulated areas, where there is little experience to serve as a guide, have found the intensive study of selected samples to be a particularly fruitful method for stimulating insights ..." (Selltiz et al.,

1976:97-98).

The same authors mentioned above have suggested that the critical features of the case study approach are the following:

1. The attitude of the investigator. This refers to the extent to which the researcher is able to develop an attitude of alertness and perceptiveness, emphasizing seeking rather than testing, in the classical sense. As regards the conduct of the inquiry, it is dynamic in nature, and is constantly in the process of reformulating and redirecting as new information is acquired.

2. The intensity of the study. This refers to the possibility of obtaining sufficient data for characterizing and explaining not only the problem, process or situation being analyzed but also features which are common to other cases.

3. The integrative powers of the investigator. These refer to his ability to put together the events, variables and actors, or the bits of information into a unified interpretation.

According to Lipset and his associates, there are, basically, two kinds of approaches which may be taken for analyzing case study material. The first category may be designated as the particularizing or idiographic kind of analysis which is restricted to description and explanation of a single problem situation in order to provide information on the present state of things and their dynamics. The second category may be termed as the generalizing or nomothetic kind of analysis which attempts to derive empirical generalizations from the study of the case material, utilizing the findings not for providing explanations for the case in itself, but as a basis for wider empirical generalizations. Lipset and his associates explain the difference between the first and second categories of case study analysis:

> "The crucial element which distinguishes these two types of analysis is the way they treat general laws and particular statements about the single case. The first kind of analysis uses general laws or regularities in order to carry out the analysis of the particular case... The second kind of analysis is just the reverse of this ... the social scientist in this kind of analysis

attempts to utilize the particular case in developing general statements." (Lipset et al., 1970: 169)

Assuming that the particularizing and the generalizing types of analysis are not mutually exclusive, (Lipset et al., 1970) the present research attempted to combine, wherever possible, elements of the first and second categories of analysis. Therefore, an effort was made to describe and analyze the process of transferring computer technology to Brazil, while, at the same time, attempting to provide some statements which might be applicable to organizations operating in similar environments. However, it is recognized that the power of generalization derived from analysis of case study material is limited. Nevertheless, considering the rather embryonic state of knowledge on the actual process of transferring technological resources between organizations in countries at different levels of development, perhaps some findings derived from the Ferranti- Cobra experience might help other organizations to gain familiarity with the problems associated with transferring computer manufacturing technology across national borders.

3.3 THE HYPOTHESES

According to Aristotle our knowledge of reality is based on the human phenomenon of perception. Broadly speaking, there is a real world of facts and objects that individuals perceive according to their experiences. Thus, in looking at the same fact, problem or situation, individuals are likely to perceive different things (Drucker, 1970; Baranson, 1969; Fayerweather, 1969), based on their cultural frame of reference or what Ansoff (1977) calls their "models of reality".

Considering that individuals from the technology-supplying and recipient organizations come from different cultural environments, and based on the review of the literature and the conceptual model guiding this research, (Figures 2.4 and 2.5) four alternative hypotheses were formulated to test whether there would be significant differences between the supplier and recipient's perceptions of factors affecting the transference of technological resources during the initial (1975-1976) intermediary, (1977-1978) and present (1979-1980) stages of the transfer process. The following hypotheses were formulated as vehicles of exploration:

HYPOTHESIS NO. 1 There are significant differences between the supplier and recipient's perceptions of individual factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

HYPOTHESIS NO. 2 There are significant differences between the supplier and the recipient's perceptions of technological factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

HYPOTHESIS NO. 3 There are significant differences between the supplier and recipient's perceptions of organizational factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

HYPOTHESIS NO.4 There are significant differences between the supplier and recipient's perceptions of environmental factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

Appendix 4 presents the method of measurement and provides operational definitions of individual, technological, organizational and environmental measures employed for testing the hypotheses. Chapter 8 presents the results obtained from testing the hypotheses and a discussion of the findings.

3.4 THE UNIT OF ANALYSIS

According to Lipset et al., the generalizing type of analysis involves "the necessity of delineating units of analysis and characterizing the units according to certain general concepts or properties". (Lipset et al., 1970:170)

The unit of analysis utilized in the present research was the actual process of technology transfer.

As stated in section 2.3, technology transfer was conceptualized as the process by which one organization transmits to another the technological resources necessary for the manufacture of a product, the implementation of a process, or the rendering of a service. The concept of technology was considered in a broad sense, including capital and intermediary goods; individual knowledge, skills, know-how and abilities; and information in general.

Considering the complexity of international technology transfer, (Rubenstein, 1974; Seurat; 1976; OECD, 1981; Mansfield, 1975; Hertz, 1980) part of the present investigation focussed on the process by which the various forms of technology were transmitted, in an attempt to discover and analyze, in so far as possible, what were the major participants, strategic variables and conditions influencing the transmission of computer manufacturing technology from one country to another. By utilizing the technology transfer process as the unit of investigation and by analyzing the matter from the technology supplier and recipient's angles, it was expected that this would provide some insights into the nature of the technology transfer problems, as perceived from each side.

3.5 THE PROCEDURE

In order to assess the supplier and recipient's perceptions of the process of transferring technological resources to Brazil and in an attempt to identify the multiplicity of variables affecting the transmission of computer production technology, this research gathered information from three different sources, as follows:

GROUP 1 - THE TECHNOLOGY SUPPLIER. This group consisted of five experts from the technology-supplying organization. These were Ferranti's executives, managers and engineers directly involved in the transmittal of technological resources to Cobra, since the initial phase of the transfer process. (1975-1976).

GROUP 2 - THE TECHNOLOGY RECIPIENT. This group consisted of nineteen experts from the recipient organization. These were the recipient's executives, managers, hardware and software engineers, and technicians also directly involved in the process of transferring computer technology to Cobra since the early stage.

GROUP 3 - COMPUTER INDUSTRY PARTICIPANTS. This group consisted of thirty two subjects, representing a cross-section of the computer industry in Brazil. It included representatives from the following organizations:

3.1 Government Agencies and State-owned Corporations. These were the Brazilian

Digital Electronics Corporation (DIGIBRAS); the Agency for Financing of Studies and Projects (FINEP); The Federal Data Processing Service (SERPRO); and the Brazilian Mechanical Corporation (EMBRAMEC).

3.2 Manufacturers of Computers and Peripheral Equipment. These were IBM do Brasil Ltda. (IBM); Burroughs Eletronica Ltda. (Burroughs); Sistemas de Informacao Distribuida S.A. (SID); Labo Eletronica S.A. (LABO); Conpart Industria Eletronica Ltda. (CONPART); Sistemas e Computadores S.A. (SISCO).

3.3 Universities. These were the Federal University of Rio de Janeiro (UFRJ); and the Catholic University of Rio de Janeiro. (PUC).

3.4 Associations and other organizations. These were the Brazilian Association of Manufacturers of Computers and Peripheral Equipment (ABICOMP); The Brazilian Computing Society (SBC); The Brazilian Society of Computer Users (SUCESU); and the Brazilian Association of Electrical and Electronic Industries. (ABNEE).

Individuals from the technology-supplying and receiving organizations were selected at random on the basis of their participation in the initial, (1975-1976) intermediary, (1977-1978) and current (1979-1980) stages of the transfer process. Since this study intended to analyze the supplier and recipient's perceptions of the factors affecting the transfer process over a fixed period of time, participation in these three stages of the process was the criterium adopted for selecting the respondents for these two grourps. These individuals were considered experts in their field of activity, in the sense proposed by Dalkey (1969) in studying strategic economic and military isssues in the United States. Perhaps, the major disadvantage of adopting this criterium was the relatively small number of subjects in both groups. On the other hand, the anticipated gains in representativeness of the data seemed to outweigh the costs. Subjects from the cross section of the Brazilian computer industry were invited to participate in this research on the basis of the investigator's access to individuals and organizations.

The field work for this research was carried out in Great Britain (GROUP 1) and Brazil. (GROUPS 2 and 3). Following the initial contact and open discussions with the technology supplier, the interview guide was designed. It was subsequently tested with two members of the supplying organization. Following the pilot test, some questions were modified to cover more situations and a few open-ended type of questions were included.

The subjects from both groups were examined through interviews and open discussions in their natural settings in England and Brazil. Eighteen out of thirty two individuals from the computer industry were interviewed during the XIII National Data Processing Congress in Brazil. The remaining interviews were held in their respective organizations.

3.6 DATA ANALYSIS AND REPORTING

In this research, the following procedures were utilized for analyzing data, drawing the figures and preparing the final report:

a) Statistical procedures. In order to test the hypotheses, student's t-tests of statistical significance were performed on the weighted data at group level, using the "T-test" subprogram within the Statistical

Package for the Social Sciences. (Nie et al., 1975). The relationship between Brazil's Gross Domestic Product and its installed computer base was tested by using the 'Crosstabs' subprogram, also available within the same statistical package. Both subprograms were run in the ICL 2980 computer system, available at the University of Bath.

b) Drawings. The graphics, isometric projections and figures in this research were produced using specially developed 'FORTRAN' programs and the 'GINOGRAF' and 'GINOSURF' libraries of subroutines. The programs were run in the Honeywell's Multics system, (Honeywell, 1979) available at the University of Bath, through the South West Universities Computer Network (SWUCN).

c) The Final Report. The original text of this study was edited with the "QEDX" editor, and the final report produced using the 'RUNOFF' text formatter. Both of these facilities were available within the multics system, at the University of Bath.

4. THE BRAZILIAN ENVIRONMENT

4. THE BRAZILIAN ENVIRONMENT

4.1 INTRODUCTION

This chapter aims to provide an overview of the Brazilian economic, political and legal background, and the regulatory framework on technology transfer transactions. It consists of three main sections. Section 4.2 gives a general view of Brazil's economic, legal and political background. Section 4.3 presents the evolution of the domestic and external sectors of the economy in the period 1970-1980. Section 4.4 presents the Brazilian regulatory framework on technology transfer transactions.

4.2 ECONOMIC, POLITICAL AND LEGAL BACKGROUND

4.2.1 ECONOMIC BACKGROUND

In 1500, the Portuguese navigator Pedro Alvares Cabral discovered Brazil, in an attempt to reach the Indies by the Western route. Initially Cabral thought he had landed on an island, so he named the country, The Island of Vera Cruz. Later, King Manuel of Portugal changed this name to Brazil, after some reserves of 'pau-brazil' (Brazil-wood) which were found there. This heavy wood, also known as lignum Brasiliense (Entick, 1770), the produce of a papilionaceous plant of the species caesalpinia echinata, much sought by sixteenth-century textile manufacturers for dyeing red, (Webster, 1853:160) became Brazil's first exploitable resource.

In subsequent years Brazil was colonized by the Portuguese and seems to have experienced its first case in international technology transfer. The Portuguese, who had been growing sugar in Portugal, Madeira and in the African colony of Sao Tome, took with them, initially to Sao Vicente and then, to the North East of Brazil what Adam Smith (1776) called the superior "knowledge of agriculture and other useful arts". As a result, the sugar plantations of the North East of Brazil became successful and were one of the main sources of economic prosperity for the country during the sixteenth and seventeenth centuries. In the second half of the seventeenth century, in view of the increased competition from the Antilles, the exports of sugar-cane declined. (Furtado, 1964). Fortunately, in the end of the seventeenth century gold and precious stones were discovered in Minas Gerais. Considering the economic importance of gold in the context of the European mercantilistic societies, the exploration of gold soon became top priority in Brazil. According to

Smith, (1776) gold imported from the Brazilian mines became so abundant for the Portuguese empire that, under the Methuen Treaty signed in 1703, Portugal imported textiles from England in exchange for gold. In the end of the eighteenth century, with the apparent exhaustion of the gold mines, the decline of the mining boom, and the series of inventions which transformed the textile industry in England, (Landes, 1969) the plantation of cotton assumed a new economic importance in Brazil. The cotton cycle, however, was relatively sort, since that by the end of the eighteenth century, coffee had been introduced in Brazil from the French Guyana. Coffee rapidly became Brazil's most successful crop in terms of exports. The growth of coffee in the South of Brazil was accompanied by the rise of the rubber plantations in the Amazon region. In this century, the exports of natural latex for the production of rubber became an important source of income and prosperity for the Amazon region until the twenties, when Brazil faced strong competition from the rubber plantations in Java.

Since the nineteenth century, except during the rubber boom, coffee has been Brazil's most important crop. As can be seen in table 4.1, until the mid-sixties, coffee represented over fifty per cent of Brazil's total exports. Not until 1973 did the relative

TABLE 4.1 BRAZIL'S COMMODITY STRUCTURE OF EXPORTS, 1955-1978. (in percentage)

	1955	1960	1964	1971	1972	1973	1974	1975	1976	1977	1978
Coffee*	59	56	53	29	27	22	12	11	24	22	18
Sugar**	3	5	2	5	10	9	16	11	3	4	3
Soybeans & derivatives	-	-	-	4	7	15	11	13	16	15	10
Iron ore	2	4	6	8	6	6	7	11	10	8	8
Manufactured goods	1	2	5	26	29	30	35	36	32	36	48
Other Primary	35	33	34	37	21	19	17	18	15	15	13
	100	100	100	100	100	100	100	100	100	100	100

Source: Central Bank of Brazil, in (Campos, 1980)

* Includes Soluble Coffee

** Includes Crystal Sugar

importance of manufactured goods (30%) exceeded that of coffee exports (22%). Nevertheless, Brazil has remained the world's largest producer and exporter of coffee. According to Campos, (1980) the production of coffee has been the main impetus behind the process of industrialization in Brazil. He distinguishes three main phases in the Brazilian industrialization process, as follows:

a) The industrialization of Sao Paulo. In the early part of this century, the expansion of coffee plantations, in response to a rising demand for coffee in the United States and Europe, (Dean, 1969, cited in Campos, 1980) led to further investments in agriculture by immigrant entrepreneurs, a diversification of agricultural exports, railroads, industrial investments, and an extraordinary period of economic growth. This incipient stage of industrialization is denominated as an "entrepreneurial export-led growth".

b) The import-substitution industrialization. In the fifties, despite the wide variety of strategies adopted by national Governments, in Latin America, the promotion of industrialization via import-substitution policies, was inspired in the Prebisch manifesto of 1949. Regarding Brazil, Campos stresses the importance of recognizing the influence of the second world war, balance of payments difficulties, the expansion of the domestic market as a result of export growth, and the Government development policies. He argues that, in the second half of the fifties, the industrialization of the country was not financed by local savings but through foreign capital in the form of direct investments and external loans. In addition, it concentrated on final goods, as opposed to the domestic production of basic inputs. In general, he suggests that, from the fifties to the early seventies, the industrialization of Brazil had been characterized by a coalition between the Government and the foreign investor, while local entrepreneurs tended to concentrate on the traditional industries or supplying the new industries.

c) The second-generation import-substitution industrialization. According to Campos, the current stage of industrialization started after the world petroleum crisis and represented, essentially, a Brazilian response to the international economic conjuncture. As demonstrated in Table 4.2, this phase of industrialization is characterized by growing imports of capital goods and intermediary inputs. Another important characteristic is the emergence of new organizational forms of co-operation for the transference of advanced, technologically intensive industries. In these areas, the Brazilian Government has been promoting tripartite joint-ventures between State companies, indigenous entrepreneurs and foreign suppliers of technology.

As Dean (1969) and Campos (1980) have suggested, the incipient industrialization of Sao Paulo by immigrant entrepreneurs, in the first half of this century, seems to have been the main impetus behind the country's industrialization process. In the fifties, Brazil, as most other Latin American countries, began to adopt import-substitution policies. (OECD, 1979) Initially, the policies of the Brazilian Government seem to have emphasized imports of capital goods and technological resources for industries producing

TABLE 4.2 BRAZIL's COMMODITY STRUCTURE OF IMPORTS, 1968-1978

	1968-72	1973	1974	1975	1976	1977	1978
Machinery & equipment	37.6	34.6	24.8	32.2	28.7	25.6	25.8
Crude oil & derivatives	10.0	11.5	22.0	25.2	31.2	31.8	31.0
Pig iron & steel	6.2	8.0	12.2	10.4	5.0	4.8	3.5
Non-ferrous metals	5.0	4.6	4.8	3.0	3.4	4.3	3.2
Organic chemicals	5.3	6.0	5.1	4.3	5.8	5.3	5.3
Others	35.9	35.3	31.1	24.8	25.9	28.2	31.2
	100	100	100	100	100	100	100

Source: Bergsman, J., Brazil Industrialization and Trade Policies, Oxford, Oxford University Press, 1970, in Campos (1980).

durable consumer goods. (Baer, 1965; Leff, 1968; Brazil, Ministry of Planning, 1969; Suzigan, 1974) In the late sixties and early seventies, the Governmental import-substitution policies appear to have concentrated on capital and intermediary goods, and sectors of high technological content such as electronics, computers, the chemical and petrochemical industry, etc. (Brazil, Presidency of the Republic, 1973, 1974; Doellinger, 1977; Bonelli, 1978; Campos, 1980).

4.2.2 POLITICAL AND LEGAL BACKGROUND

Between 1500 and 1821 Brazil was ruled under the Portuguese colonial regime. In 1808, when Napoleon's troops were trying to invade Portugal, the Royal Family fled to Brazil, forming in 1815 the United Kingdom of Brazil and Portugal. The King, Joao VI remained in Brazil until 1821, when he returned to Portugal. In 1822, his son, Prince Regent Pedro, proclaimed Brazil's independence from Portugal. Emperor Pedro I ruled Brazil until 1831, when he abdicated in favour of his son, Pedro II, who stayed in power until a new form of Government was installed in the country on November 15th, 1889. Since the proclamation of the Republic in 1889, Brazil has adopted a federal form of Government. Between the proclamation of the Republic and the 1964 intervention of the Brazilian military, (Stepan, 1971) Brazil had twenty four presidents. Since 1964 Brazil has been ruled by five military presidents. In 1979, the Electoral College elected General Joao Batista de Oliveira Figueredo to serve until March 1985. According to the National Westminster Bank (1979) and the Bank of London and South America (1980), this new administration is committed to the further gradual political liberalization of the country. As one veteran Brazilian politician commented, since the late seventies, Brazil seems to be "making the transition to real democracy" (Financial Times, 1978:I).

According to the present constitution adopted in 1967, and revised in 1969, the Federal Government exerts exclusive jurisdiction on certain matters such as electoral legislation, national security, the national debt, and the foreign, monetary and fiscal policies. In formulating economic policy the President is assisted by the Economic Development Council (CDE). The permanent members of the CDE are the Ministers of Industry and Commerce, Finance, Agriculture and Interior. Other ministers may join the CDE according to the nature of the matters being discussed. During the CDE sessions, the President of the Republic presides over the Council, assisted by his Planning Secretariat.

The organs directly connected to the President of the Republic are the High Command of the Armed Forces; the Attorney General's office; the Department for the Administration of Public Services; the General Staff of the Armed Forces; the National Security Council; the National Information Service, the Planning Secretariat, and the Civil and Military Households.

Since 1960, the Brazilian Government opperates in the Federal District of Brasilia. Federal legislation is determined by the National Congress which is composed of a Senate and a Federal Chamber of Deputies. In 1979, the Senate had 67 members, while the Chamber of Deputies was composed of 420 representatives from the various states. (EIU, 1979b). The President of the Republic is selected by an electoral college, subject to approval by the National Congress. The President exerts executive power for six years and is not eligible for re-election. The senators and deputies are elected for eight and six years, respectively.

The judicial system is comprised of The Federal Supreme Court, The Federal Court of Appeals and other tribunals such as Military, State and Labour

Courts.

Presently, Brazil has twenty-two states, four territories, and the federal district of Brasilia. Although each state has its own constitution and executive, legislative and judicial powers, they operate in conformity with the broader legal framework and policies of the Federal Government.

4.3 THE EVOLUTION OF THE ECONOMY

4.3.1 THE DOMESTIC SECTOR

Between 1947 and 1962, the Brazilian economy managed to keep the Gross Domestic Product (GDP) growing at an average annual rate of 6.6 per cent (Stoneman, 1981). During 1963 and 1964, the economy experienced what Campos (1980:12) calls "stagflation". In other words, the Brazilian economy showed signs of stagnation and inflation "well before this hybrid creature made its appearance in the European scene". The real growth rate of the Gross Domestic Product declined from 10.3 in 1961 to 5.3 in 1962 and 1.5 percent in 1963. According to the Getulio Vargas Foundation's estimates, shown in Table 4.3, the general price index grew from 37.0 in 1961 to 51.6 in 1962, reaching the unprecedented levels of 75.4 and 90.5 per cent in 1963 and 1964, respectively. The Economic and Social Planning Institute (IPEA) suggested that the 1964-1964 period was characterized by a general slowing of economic activity, relatively high public sector deficit, a growing climate of political instability, a reduction in foreign investments and a decline in domestic savings rates. Following the military intervention in 1964, the Brazilian Government

TABLE 4.3

BRAZIL'S ANNUAL RATES OF INFLATION 1960-1980

YEAR	GENERAL PRICE INDEX	RIO DE JANEIRO COST OF LIVING INDEX
1960	29.2	28.2
1961	37.0	34.0
1962	51.6	51.6
1963	75.4	69.6
1964	90.5	92.1
1965	56.8	65.9
1966	38.0	41.3
1967	28.4	30.4
1968	24.2	22.0
1969	20.8	22.6
1970	19.8	22.4
1971	20.4	20.1
1972	17.0	16.6
1973	15.1*	12.7 *
1974	28.7	27.6
1975	27.7	29.0
1976	41.3	41.9
1977	42.7	43.7
1978	38.7	38.7
1979	53.9	53.7
1980	100.2	82.8

Source: Getulio Vargas Foundation, in Stoneman (1980)

* Subsequently estimated at approximately 26%

continued to emphasize industrialization by import-substitution, but at the same time, implemented an economic stabilization programme which envisaged, among other things, the control of the level of inflation, the enlargement of investment opportunities, the promotion of domestic savings, the reduction of the public sector deficit, and changes in the tax collection system to improve revenue. (IPEA, 1978; Stoneman, 1981).

In the late sixties and early seventies, substantial progress had been made by the economy. (The World Bank, 1981). By 1973 the General Price Index had declined to 15.1 per cent, the public deficit had been eliminated, the balance of trade registered a surplus of US$ 7 million, and the real GDP growth reached its highest level in Brazil's history. (14%). During the 1968-1973 period the average annual growth of the real GDP exceeded ten per cent. According to the Financial Times, (1979) the Brazilian "economic miracle" might have continued at this pace, except for the world petroleum crisis late in 1973.

In general, the relatively rapid industrial expansion of the country in the last two decades, seems to have produced some structural changes in the economy. According to the Organization for Economic Co-operation and Development, (OECD) since the late seventies, because of its rapid shifts in the pattern of output and trade, Brazil was considered as the leading industrial producer of the Third World. (OECD, 1979). The emergence of Brazil as a "Newly Industrializing Country" (NIC) was characterized, among other things, by an expansion of exports with a growing share of manufactures on world markets. (OECD, 1979; The World Bank 1981, 1982). Regarding Brazil's recent pattern of economic growth, one article in The Banker stated:

> "Since the 1960s (Brazil) has undergone a classic industrial revolution. Major new industries including petrochemicals, steel, capital goods, automobiles (with annual production already putting Brazil in the million-plus league) have sent the country shooting up the table to become number ten among the world's economic powers ...." (The Banker, 1979:31).

4.3.1.1 GDP AND THE LEVEL OF INVESTMENTS

Table 4.4 shows Brazil's Gross Domestic Product and Gross Fixed Capital Formation rates in the

TABLE 4.4 REAL GROSS DOMESTIC PRODUCT AND GROSS FIXED CAPITAL FORMATION RATES, BRAZIL 1960-1980

YEAR	REAL GDP (ANNUAL % INCREASE)	GROSS FIXED CAPITAL FORMATION (% of GDP)
1960	9.7	17.6
1961	10.3	18.6
1962	5.3	20.0
1963	1.5	20.5
1964	2.9	19.9
1965	2.7	18.4
1966	5.1	19.6
1967	4.8	19.4
1968	9.3	21.2
1969	9.0	22.1
1970	8.9	22.3
1971	13.3	22.8
1972	11.7	22.9
1973	14.0	23.0
1974	9.8	24.2
1975	5.6	25.7
1976	9.0	24.1
1977	4.7	22.6
1978	6.0	22.5
1979	6.4	22.1
1980	8.0	22.6

Sources: 1960-1971 (IPEA, 1978)
1972-1980 Central Bank of Brazil

period 1960-1980. An examination of table 4.4 indicates that in the 1968-1974 period, GDP growth, in real terms, averaged over 10 per cent per annum. From 1974 onwards, the Brazilian economy began to reflect some problems associated with the deep changes which occurred in the international petroleum market. As a non-oil developing country importing approximately eighty per cent of its petroleum consumption, (The World BanK, 1981) Brazil suffered the impact of the increases in world oil prices. Among other things, relatively lower GDP growth rates were observed after 1973. The real annual rate of GDP changed from 14% in 1973 to 9.8% in 1974%.

During the period 1974-1980, despite the unfavourable world economic conjuncture, and associated balance of trade problems, the GDP seems to have recovered reasonably well for a non-oil developing country. In 1976 the real GDP grew at 9 per cent. By the end of 1978, Brazil's GDP was estimated to have been US$ 188.6 millions, one of the ten largest among the nations of the Western World (Gabeira, 1981). In 1980, notwithstanding the recent increases in oil prices and the highest level of inflation ever reached in Brazil's history (100.2%), the GDP recorded a real growth rate of 8%. In general, one factor which seems to have contributed significantly to the sustained growth of the economy, has been a relatively high rate of capital formation through domestic savings and foreign investments. As can be seen in Table 4.4 in the period 1974-1980, the rate of gross capital formation averaged 23.4% of the GDP. According to the Central Bank of Brazil, in 1975, the relative contribution of domestic and foreign savings to the gross fixed capital formation was 78.8 and 21.2 per cent, respectively. In 1980, these proportions changed to 75 and 25 per cent, suggesting a higher participation by foreign investments.

4.3.1.2. SECTORAL OUTPUT

Table 4.5 presents Brazil's sectoral real output variation in the period 1970-1980, in percentage terms. Figure 4.1 illustrates graphically, the annual real output variation of the GDP, and that of the industrial and agricultural sectors separately. Figure 4.2 presents the results of the services sector divided into two subsectors, namely, Commerce, and Transport and Communications. In general terms, an examination of Table 4.5 and figure 4.1 and 4.2 seems to indicate that, after 1973, there has been a trend towards relatively lower growth rates of sectoral output.

4.3.1.2.1 AGRICULTURE

Regarding the performance of the agricultural sector, an examination of table 4.5 and figure 4.1 appears to indicate that, since the early seventies, it has experienced more problems than the industrial and services sectors. During the 1970-1980 period the agricultural sector grew at an average of approximately 5% per year. As it can be seen in Figure 4.1, the agricultural production rose by 11.4% in 1971, 8.5% in 1974, and 9.6% in 1977, compared with the limited

TABLE 4.5 SECTORAL REAL OUTPUT VARIATION, BRAZIL 1970-1980 (ANNUAL PERCENTAGE CHANGE)

SECTOR	70	71	72	73	74	75	76	77	78	79	80
AGRICULTURE	1.0	11.4	4.1	3.5	8.5	3.4	4.2	9.6	-1.7	3.2	6.8
INDUSTRY	10.4	14.3	13.4	15.8	9.8	6.2	10.7	3.9	8.1	6.9	8.0
COMMERCE	10.3	14.0	12.7	14.8	9.3	3.5	8.7	3.5	5.9	6.3	7.2
TRANSPORT & COMMUNICATIONS	10.5	7.4	11.9	17.1	12.7	11.8	7.5	4.1	6.8	10.1	12.7
TOTAL GDP	8.9	13.3	11.7	14.0	9.8	5.6	9.0	4.7	6.0	6.4	8.0

Sources: 1970-1972 Getulio Vargas Foundation
1973-1980 Central Bank of Brazil

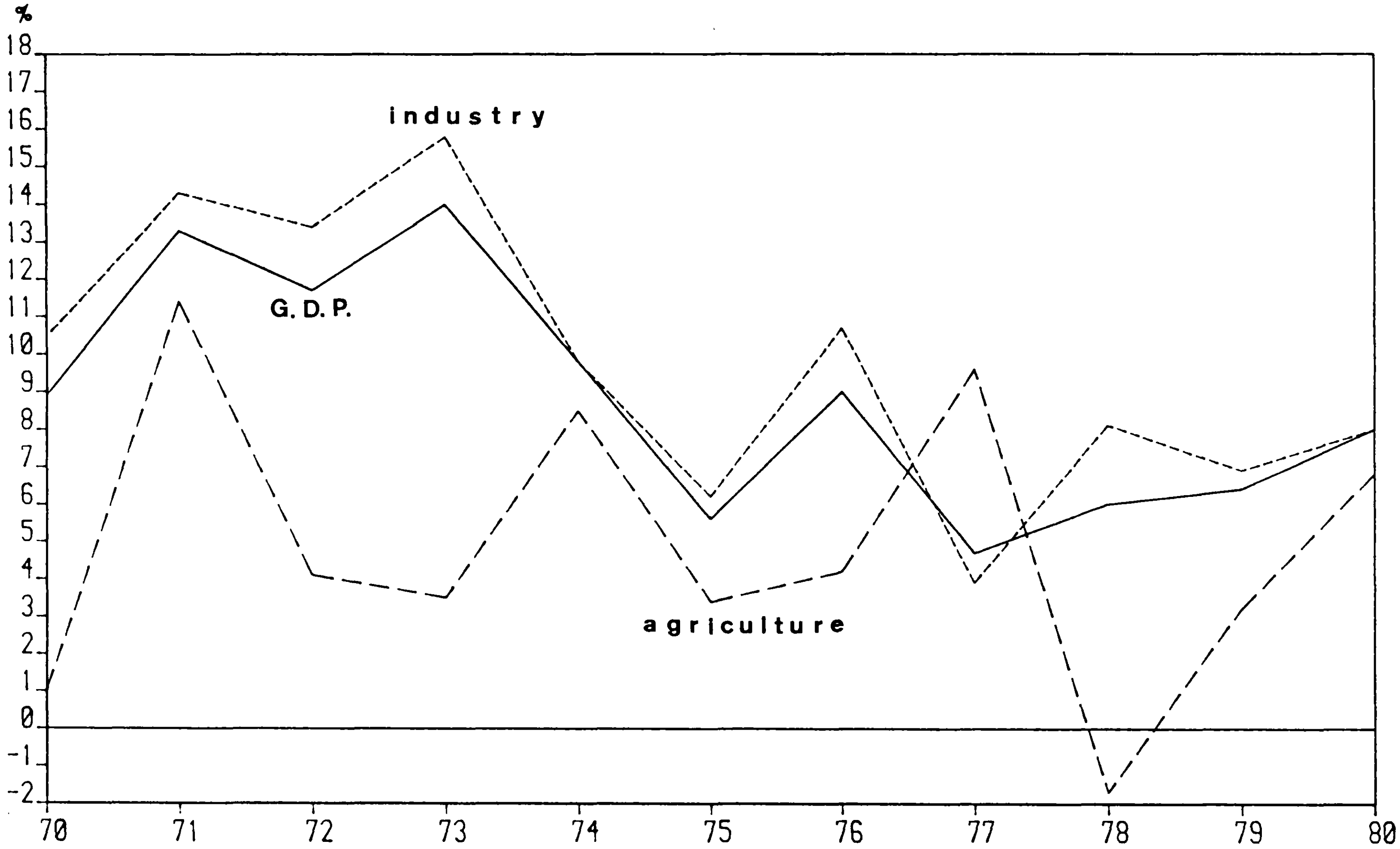


Figure 4.1 G.D.P., Industrial and Agricultural Output Variation 1970-1980 (%)

Sources : 1970-1972 Getulio Vargas Foundation

1973-1980 Central Bank of Brazil

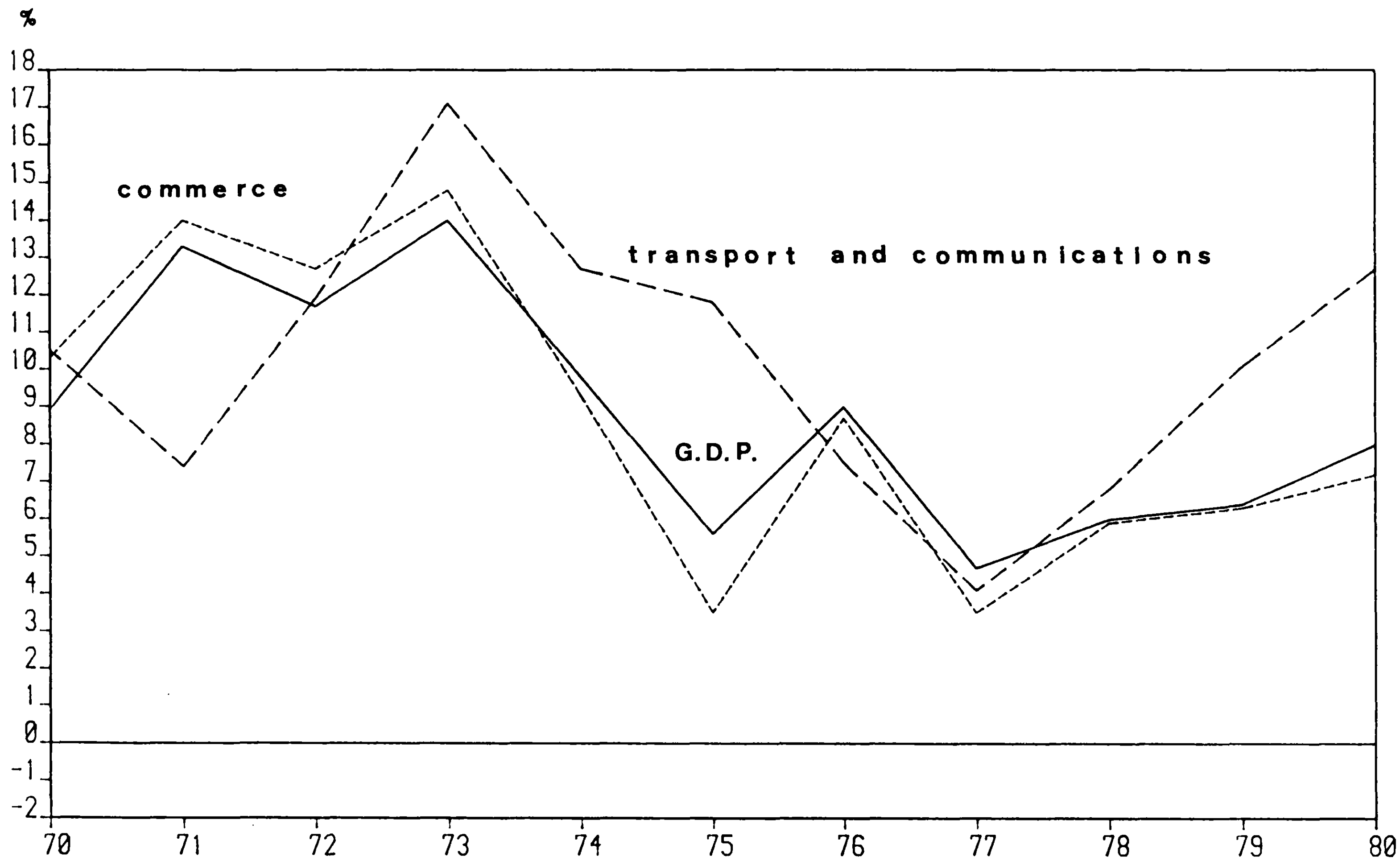


Figure **4.2** G.D.P., Commerce, Transport and Communications Output Variation (%)

Sources : 1970-1972 Getulio Vargas Foundation

1973-1980 Central Bank of Brazil

expansion of 1971 (1%) and negative growth of 1978 (-1.7%). In 1978, however, according to the Central Bank of Brazil, agricultural activities were affected by severe droughts and frosts. Apparently, these climatic problems led to a substantial decline in agricultural production of corn, soyabeans and rice, a reduction in the exports of these products, and an overall negative growth rate for the sector.

Traditionally, agriculture has played a major role in the Brazilian economy, providing, in 1976, employment for approximately 49% of the country's population. According to Banco do Brasil (1979), in 1977, the 9.6% growth rate observed in the sector has not been a function of greater capital or labour productivity, but the result of a 22% increase in the area of cultivation, which changed from 36.7 million hectares (1970-1972) to 44.8 million hectares in 1976-1978. Although the production of coffee remains Brazil's most important agricultural activity in terms of export earnings, in recent years, the relative importance of soybeans has been growing steadily. (Table 4.1). Other important crops are cocoa, rice, corn, onions, sugar cane, cotton, peanuts, white potatoes, beans, tobacco leaves, oranges, cassava, tomatoes and wheat.

Since the sixties, the relative participation of agriculture in the GDP has been declining. In 1960, the agricultural product represented 23.2% of the GDP,, and 11.2% in 1978. In the late seventies, in an attempt to improve the performance of the primary sector and optimize Brazil's vast agricultural potential, the Government has given special priority to the development of the sector. Special credit lines were established through Banco do Brasil, and assistance programmes set up by the Ministry of the Interior, in a massive effort to modernize the rather traditional farming, fishing and cattle raising techniques.

4.3.1.2.2. INDUSTRY

Table 4.5 and figure 4.1 show the evolution of the industrial sector. Between 1970 and 1973, the industrial sector, which comprises manufacturing, mining, construction and public utilities, grew at an average rate of 13%, reaching its highest level in 1973 (15.9%). Since 1974, however, the industrial sector has been growing at lower rates, recovering reasonably in 1976 (10.7%), 1978 (8.1%) and 1980 (8%). In 1977, when the industrial product grew at its lowest rate (3.9%), in the period under analysis, it accounted for approximately 31% of the GDP.

The manufacturing sector is particularly important for the Brazilian economy, since most of the post-war industrial expansion of Brazil seems to be linked with the growth of manufacturing industries producing durable consumer goods such as household appliances, motor vehicles, rubber products, office equipment, etc.

The evolution of the manufacturing sector between 1972 and 1980 is presented in table 4.6. As can also be seen in table 4.6, the manufacturing sector tended to grow at relatively lower rates after 1973, particularly in 1975 (3.8%) and 1977 (2.7%). In 1977, in view of the further slowing of economic activity the

TABLE 4.6 BRAZIL'S MANUFACTURING SECTOR, 1972-1980. REAL ANNUAL RATES OF GROWTH

	1972	1973	1974	1975	1976	1977	1978	1979	1980
NON-METALLIC MINERAL PRODUCTS	13.8	16.3	14.8	9.0	12.1	8.3	5.6	5.5	6.5
METALLURGY & MECHANICAL ELECTRICAL & COMMUNICATIONS EQUIPMENT	15.6	17.4	8.1	8.2	15.3	1.7	6.6	8.6	10.8
TRANSPORT EQUIPMENT	22.5	27.6	18.8	0.5	7.4	-2.7	14.2	5.1	2.0
PAPER & CARDBOARD	7.5	9.4	4.3	-14.8	21.0	1.8	11.7	12.8	9.6
RUBBER PRODUCTS	13.0	12.4	10.8	4.7	11.2	-2.0	6.7	6.6	9.7
CHEMICALS, COSMETICS & PLASTICS	16.3	22.1	18.4	3.0	18.4	0.2	14.3	13.4	9.6
TEXTILES & CLOTHING	4.0	8.4	-23.0	3.4	7.0	-2.3	6.7	4.9	6.5
FOOD PRODUCTS, BEVERAGES & TOBACCO	13.6	10.6	6.5	1.4	12.1	8.2	5.4	3.7	2.9
TOTAL MANUFACTURING	14.0	16.3	7.6	3.8	12.8	2.7	7.6	7.0	7.6

Source: Central Bank of Brazil

industrial activities mostly affected were transport equipment (-2.7%), and textile and clothing (-2.3%). In subsequent years, however, the manufacturing sector performed well, registering annual growth rates above 7%.

4.3.1.2.3. SERVICES

The evolution of the services sector, subdivided into Commerce and Transport and Communications, is presented in Table 4.5 and illustrated in figure 4.2. As shown in Table 4.5 and figure 4.2, in general, the services sector achieved lower growth rates since 1974. This sector, which accounts for over fifty per cent of Brazil's Gross Domestic Product since the sixties, seems to have suffered the direct impact of the world petroleum crisis. Since highways are the principal mode of transportation in Brazil, representing, in 1976, approximately 80% of the freight traffic and over 90% of passenger traffic, the transport and communications sector was particularly affected by increases in petroleum prices. The real growth rates of transport and communication activities declined from 17.1% in 1973 to 12.7% (1974), 11.8% (1975), 7.5% (1976) and 4.1% in 1976, the lowest level registered in the period 1980-1980. As from 1977, the growth rates tended to improve, especially in 1979 (10.1%) and 1980 (12%).

The commerce sector also seems to have experienced lower growth rates after the oil crisis late in 1973. From relatively high growth rates in the period 1970-1973, it reached its lowest level in 1975 and 1977 (3.5%). In subsequent years, however, it experienced higher rates of growth.

4.3.2 THE EXTERNAL SECTOR

4.3.2.1. INTERNATIONAL BALANCE OF PAYMENTS

Between 1968 and 1973, when a process of rapid economic expansion was observed in Brazil, the country's balance of payments registered surpluses, reflecting a tendency of absorbing foreign investments and external loans to finance the industrialization programmes. However, in 1974, in view of the substantial deficit in the current account (US$ 6.8 billions), Brazil's balance of payments recorded the highest deficit in its history. (US$ 1.0 billion).

Table 4.7 presents Brazil's Balance of Payments in the period 1970-1980, and figure 4.3 illustrates the balance of trade. As can also be seen in figure 4.3, in 1974, the balance of trade recorded an unprecedented deficit of over US$ 4.5 billions. As shown in Table 4.7, the largest contributor to the balance of trade deficit was the doubling of imports from 6 to 12 US$ billions. In 1974, the imports of petroleum and derivatives more than tripled, representing nearly half of the balance of trade deficit. This deteriorated balance of trade remained in deficit until 1980, except for a small surplus registered in 1977 (US$ 7 millions).

TABLE 4.7 BRAZIL'S BALANCE OF PAYMENTS, 1970-1980 (in US$ Millions)

BALANCE OF PAYMENTS	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
A - BALANCE OF TRADE	232	-341	-244	7	-4.563	-3.499	-2.218	96.8	-988	-2.840	-2.829
EXPORTS (FOB)	2.739	2.904	3.991	6.199	-7.968	8.670	10.128	12.120	12.651	15.244	20.132
IMPORTS	-2.507	-3.245	-4.235	-6.192	-12.531	-12.169	-12.347	-12.023	-13.639	-18.024	-22.961
B - SERVICES (NET)	-815	-980	-1.250	-1.664	-2.313.	- 3.213	-3.919	-4.134	-4.975	-7.920	-10.212
C - TRANSFERS ABROAD (NET)	21	14	5	27	0	0	4	0.2	72	18	155
D - BALANCE ON CURRENT A/C	-562	-1.307	-1.489	-1.630	-6.876	- 6.712	-6.133	-4.037	-5.842	-10.742	-12.886
E - BALANCE ON CAPITAL A/C	1.015	1.846	3.492	3.687	5.894	6.161	6.866	5.269	9.439	7.657	9.804
F - ERRORS AND OMISSIONS	92	-9	436	121	-67	-399	458	-602	333	-130	-408
G - SURPLUS (+) OR DEFICIT (-)	545	530	2.439	2.179	-1.049	-950	1.192	630	3.880	-3.215	-3.490

Sources: 1970-1978 Getulio Vargas Foundation
1979-1980 Central Bank of Brazil

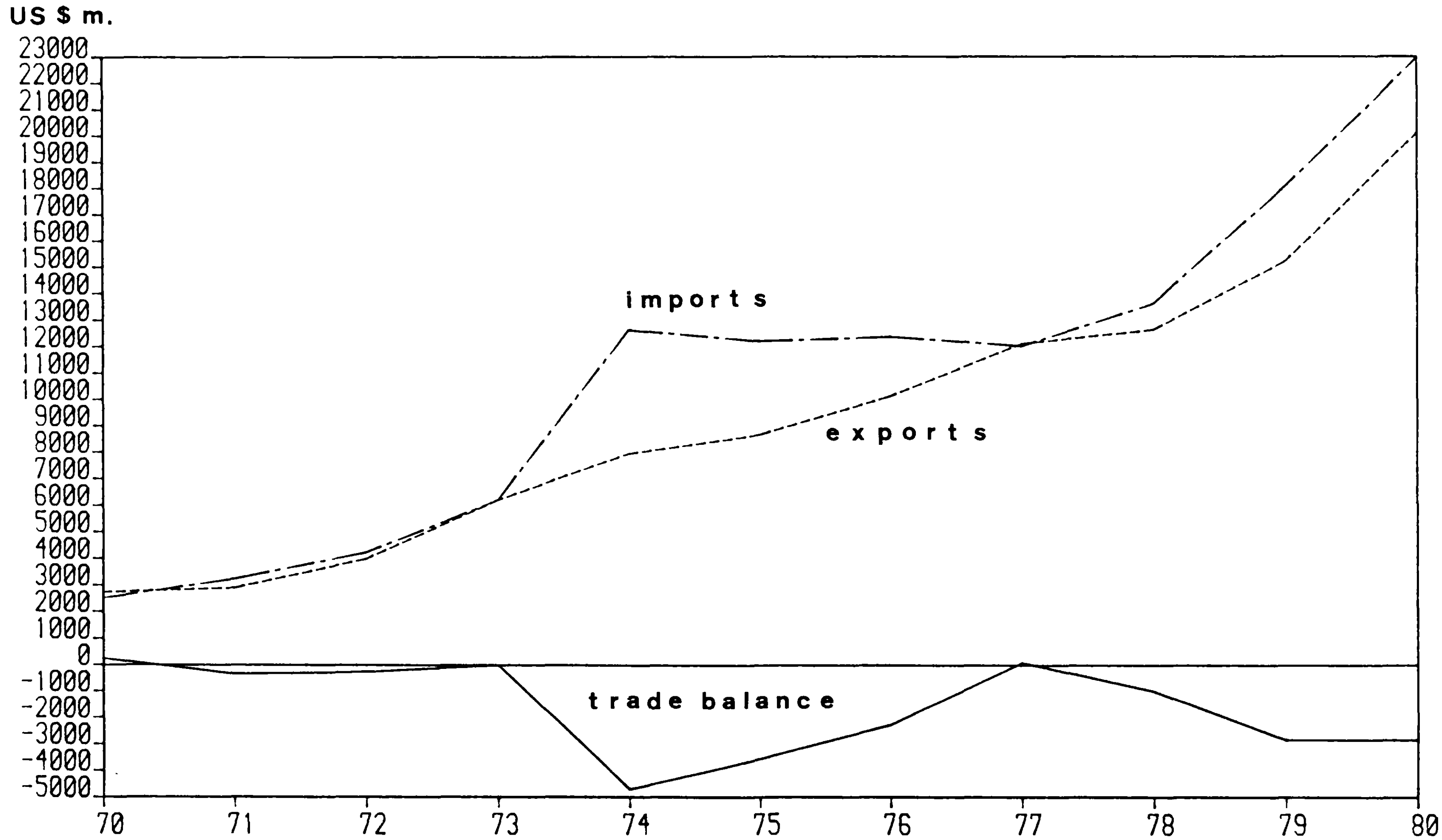


Figure **4.3** Brazilian Imports, Exports and Balance of Trade 1970-1980 (In US $ Millions)

Source : Central Bank of Brazil

As regards the capital account of the international balance of payments, an examination of table 4.7 indicates that it has remained in surplus throughout the 1970-1980 period. It seems that this can be attributable to two main factors: The level of foreign investment in the country and Brazil's medium and long-term loans. According to Central Bank of Brazil's estimates, the amount of net foreign investments in Brazil rose from US$ 337 millions in 1972 to US$ 1,923 millions in 1980. In other words, the net inflow of capital in the form of foreign direct investment has grown at an average annual rate of over 24% in the period 1972-1980. In 1980, the total amount of foreign direct investments represented approximately 19.6% of the surplus of the capital account. The Brazilian loans and financing with private banks and international organizations and government agencies reached over US$ 11 billion in 1980.

Figure 4.4 illustrates the structure of Brazilian imports in the period 1970-1980. An examination of figure 4.4 reveals the rising importance of petroleum and derivatives in the context of the Brazilian balance of trade. In 1970, imports of petroleum and derivatives represented 10.9% of the total imports, consumer goods (14.7%), raw materials (37%) and capital goods (37.7%). In 1975, the relative

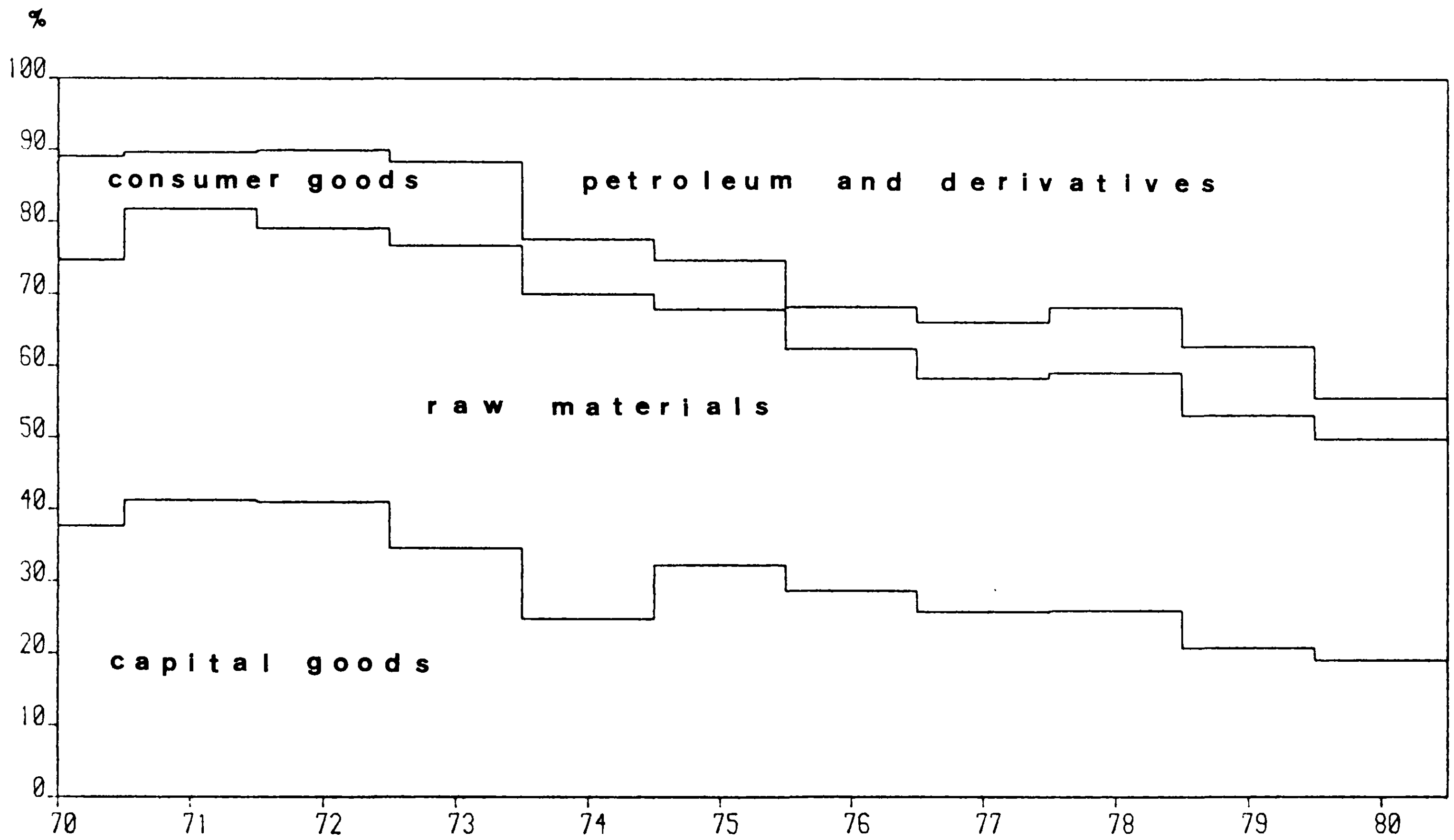


Figure **4.4** The Structure of Brazilian Imports 1970 - 1980

Sources: 1970 - 1976 Bonelli e Facanha (1978)

1977 - 1980 Central BanK of Brazil

importance of petroleum had increased to 25%, while the other items decreased to 6.8% (consumer goods), 35% (raw materials) and 32.3% (capital goods). In 1980, imports of petroleum and derivatives increased to 44.5%, while the other items further reduced their relative participation to 5.7% (consumer goods), 30.7% (raw materials) and 19.1% (capital goods). In 1980, the total amount spent on imports of petroleum and derivatives (US$ 10.210 million) corresponded to over 50% of Brazilian exports, 18.9% of the gross foreign debt, and 78.4% of the amount spent on debt service. (Amortization and net interest) This seems to indicate briefly, the extent to which, the Brazilian economy was affected by the increases in world petroleum prices.

One factor contributing to the growing deficit in the current account, has been the increasing deficit in the services account, which includes the net values of transportation, interest, profits and dividends, and other services. In 1980, net interest remittances totalled US$ 7,457 millions, which corresponded to approximately 57% of the deficit in the current account, as compared with 30% in 1973. A substantial amount of the services deficit seems to be attributable to Brazil's massive foreign debt.

Table 4.8 presents the evolution of Brazil's foreign debt and international reserves, in the period

TABLE 4.8 BRAZIL'S DEBT AND INTERNATIONAL RESERVES, 1970-1980 (in US$ Millions)

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
GROSS DEBT	5,295	6,622	9,521	12,572	17,166	21,171	25,985	32,037	43,511	49,904	53,847
INTERNATIONAL RESERVES	1,187	1,746	4,183	6,417	5,252	4,041	6,544	7,256	11,895	9,689	6,913
NET DEBT	4,108	4,876	5,338	6,155	11,914	17,130	19,441	24,781	31,616	40,215	46,934
EXPORTS	2,739	2,904	3,991	6,199	7,968	8,670	10,128	12,120	12,651	15,244	20,132
RATIO NET DEBT/ EXPORTS	1.50	1.68	1.34	0.99	1.50	1.98	1.92	2.04	2.50	2.63	2.33

Sources: 1970-1978 Getulio Vargas Foundation
1979-1980 Central Bank of Brazil

1970-1980. An examination of Table 4.8 reveals that the ratio net debt/exports evolved from 0.99 in 1973 to 2.33 in 1980. In other words, in 1973 only one year of exports would be sufficient to cover the country's net debt, as opposed to the equivalent of two years and four months in 1980. In 1980, the public sector was responsible for 69.2% of the total debit, whereas the private sector share was 30.8%. The question of Brazil's massive foreign debt has been a source of much concern and discussion. In 1979, one article in the Banker stated:

> "An increasing number of foreign bankers are finding the country's debt, US$ 43.5 billions at the end of 1978, awesome. Yet, aware of the country's resource potential, and rating it politically stable, they have shared the optimism of Brazil's expansion-minded technocrats. They awarded the country a high credit rating and the foreign banks poured into Sao Paulo and Rio" (The Banker, 1979)

The same article suggests that increasing amounts of foreign resources were utilized to finance the big investments in the country's capital goods and resource industries, as well as to cover the increasing deficits in the Balance of Trade, largely affected by the rising petroleum prices. Although Brazil's total debt seems substantial, as it can be seen in Table 4.8, to some extent, it has been mitigated by the relatively high level of international reserves held by the country. (National Westminster Bank, 1979). Regarding Brazil's extreme indebtedness, one Government official provided the following comment:

> "If you owe your bankers a small sum you have to do what they say. If you owe them as much as we owe our bankers, then the roles tend to be reversed". (Financial Times, 1978:I).

4.3.2.2 FOREIGN TRADE

Table 4.9 shows Brazil's geographic distribution of trade in the period 1972- 1980, in percentage terms. Regarding exports, the European Economic Community (EEC) seems to be Brazil's most important market since 1972. In addition, a substantial value of Brazilian imports also derived from the EEC. Recently, however, Brazil has had a trade surplus with the EEC countries. The second most important export market for Brazil are the United States. Traditionally, Brazil has had trade deficits with the United States. Another important trade area for Brazil is the Latin American Free Trade Association

TABLE 4.9 BRAZIL'S FOREIGN TRADE, 1972-1980.

* (from January to November)

	EXPORTS			IMPORTS		
	1972-1976	1978	1980 *	1972-1976	1978	1980 *
UNITED STATES	18.9	22.7	17.3	25.3	21.1	17.7
E.E.C.	31.4	29.5	27.0	24.8	18.6	15.3
EFTA	4.3	3.9	3.4	5.3	3.8	2.7
LAFTA	10.3	10.7	15.6	3.2	9.4	9.0
COMECON	7.1	5.8	6.3	1.5	1.4	1.1
JAPAN	6.7	5.1	6.2	8.2	9.1	4.5
OPEC	5.7	7.5	7.7	20.2	29.9	39.8
OTHERS	15.6	14.8	16.5	11.0	6.7	9.9
TOTAL	100	100	100	100	100	100

Source: Central Bank of Brazil

(ALALC). Although Venezuela and Equador are part of ALALC, their relative share of foreign trade with Brazil appears under the OPEC countries. In recent years, the OPEC countries have been absorbing a growing share of Brazilian exports. Nevertheless, in view of Brazil's increasing imports of petroleum and derivatives, as shown in figure 4.4, since 1974 Brazil has been having substantial trade deficits with the OPEC countries, particularly Saudi Arabia, Iraq, Kuwait, Venezuela, Iran and Gabon. Between January and November 1980, Brazil's trade deficit with the OPEC countries reached over US$ 7 billion. Since 1972 Brazil has been expanding its exports to the Socialist countries of the Mutual Assistance Economic Council (COMECON). Japan also constitutes another important trading partner for Brazil, both in terms of exports and imports. Between January and November 1980, Brazil managed to achieve trade surpluses with Japan, LAFTA, EEC, COMECON, and the European Free Trade Association (EFTA).

4.4 REGULATORY FRAMEWORK ON TECHNOLOGY TRANSFER

4.4.1 THE NATIONAL INSTITUTE OF INDUSTRIAL PROPERTY

In December 1970, the Brazilian Government created the National Institute of Industrial Property (INPI) as a federal autarchy connected with the Ministry of Industry and Commerce.

The Institute's main objectives were "to execute, nationally the regulations which control the industrial property, in view of its social, economic, juridical and technical end". Beside these attributions, the Institute was designed, and aimed at the country's economic development process, to take "measures to accelerate and regulate the transfer of technology and establish better conditions for negotiation and utilization of patents". The sole paragraph of Law No. 5648 of December 11, 1970 which created the Institute, also stressed that it should "issue reports as to the convenience of signing, ratifying or denouncing conventions, treaties, pacts or agreements on industrial property". (Brazil, National Congress, 1970).

The regulatory mission of the National Institute of Industrial Property regarding technology transactions was emphasized by Law No. 5772 of December

21, 1971, which formalized the Brazilian Code of Industrial Property. Article 126 of this law stated:

> "All the acts or contracts which involve the transfer of technology are hereby subject to legalization by the National Institute of Industrial Property, according to article 2, sole paragraph, of Law No. 5.048 of December 11, 1970" (Brazil, National Congress 1971).

Although the National Institute of Industrial Property was established in 1970 for regulating the flow of technology and providing a legislative framework on the registration of patents and trademarks, the idea of protecting the intellectual property of inventors and granting them exclusive privileges was not new in Brazil. The juridical basis of the patent grant, was laid by Dom Joao VI, in 1809, approximately one year after the Portuguese royal family had fled to Brazil, when Napoleon's troops were trying to invade Lisbon in an attempt to get Portugal's alliance against Great Britain. Thus, the Brazilian Patent Law of July 15, 1809, signed when Rio became the seat of the Portuguese Empire, became the fourth modern legislation on patents introduced in the world, following the English, United States', French statutes. (United Nations, 1964:10) The basic principles of the Brazilian Patent Law of 1809 were:

"It being highly convenient that inventors of any new machinery should have an exclusive privilege for a certain time, I hereby order that no matter who should be in such a position to submit the plans of his invention to the Royal Board of Trade which verifying that such invention is really worthy should be given the exclusive right for the period of fourteen years after which the invention should be published so that all the nation might have the right to share the benefits of such invention". (United Nations, 1964: 10)

Perhaps, it is interesting to note a dual preoccupation by the law. First, regarding the "exclusive privilege" intended to reward individuals as an incentive for their inventions. Second, concerning the macro economic implications of the technology, "so that all the nation might have the right to share the benefits of such invention".

Later, in July 7th 1884, under the reign of Dom Pedro II, Brazil joined the International Union for the Protection of Industrial Property, which was established by the Paris Convention in May 1883. The United Kingdom, Belgium, France, Italy, Netherlands, Portugal, Spain, Switzerland and the Republic of

Viet-Nam also joined the "Paris-Union" in 1884, while the United States, Japan and Germany adhered in 1887, 1899 and 1903, respectively. (United Nations, 1964:14)

Under the main provisions of the Paris Convention is the principle of "national treatment". (Article 2). Basically it establishes that nationals and non-nationals be given the same rights by member states, whether applicants or patentees live in the country or are domiciled in a participating country. However, this principle does not necessarily mean "reciprocal treatment" for the member states. (United Nations, 1964:14) Thus, according to the national treatment principle, each participating nation sets its own framework and laws concerning the rights and obligations connected with industrial property and applies the legislation uniformly to nationals and non-nationals.

The evolution of the Brazilian regulatory framework pertaining to patents, licensing and technology transactions is summarized in a chronological order in Table 4.10.

Table 4.10 REGULATORY FRAMEWORK ON BRAZILIAN TECHNOLOGY TRANSACTIONS

INTERNATIONAL CONVENTIONS	
1883 - 1925	Paris Convention (The Paris-Union)
1891 - 1925	Arrangement of Madrid
1910	Buenos Aires Convention
1947	Arrangement of Neuchatel
NATIONAL LEGISLATION	
1809	Brazilian Patent Law
1945	Law No. 7903 (Industrial Property Law)
1946	Paragraph 17, article 141, of the Brazilian Constitution
1958	Decree No. 436 - Established that Bank of Brazil should register technology transactions
1962	Law No. 4131 - Regulates foreign capital
1964	Law No. 4390 Alters Law 4131
1965	Decree-Law No. 5572 Regulates Law 4390
1969	Decree-Law 1005 Code of Industrial Property
1970	Law No. 5648 (Creates the INPI)
1971	Law No. 5772 Code of Industrial Property
1975	INPI Act No. 15 Consolidates the Legislation on Technology Transactions

4.4.2 THE CENTRAL BANK OF BRAZIL

Although the INPI was established in 1970 to take measures to control the technology transactions in the country, it seems that until 1975 there were no explicit policies guiding its actions, and a parallel control of technology contracts was being performed by the Central Bank of Brazil.

Since 1962, owing to lack of adequate national policies relating to matters of technology transfer, registration and control over payments involving foreign exchange remittances for technical assistance, and licensing agreements concerning the utilization of marks and patents, were Central Bank of Brazil's attributions (Figueredo, 1972:119-146). Thus, it appears that even after the INPI was created in 1970, the Department of Registration of Foreign Capital and the Foreign Trade Section of the Central Bank were, the institutions exercising a parallel control over technology transfer contracts. According to Figueredo, they were led to assume increasingly important roles in the regulatory framework of technology transactions, acting as "interpreters of the legal texts and negotiators of licensing agreements and similar contracts" (Figueredo, 1972:119). This point is supported by Baer's view of the role of the Central

Bank of Brazil's departments in the context of technology transfer policies: "The influence of these institutions is felt through their interpretation of laws and through their power of approval or disapproval of licensing agreements, technical assistance contracts, etc". (Baer et al., 1973:30).

4.4.3 THE CONSOLIDATION OF THE LEGISLATION

A study published in 1972 by the United Nations emphasized the importance for developing countries to establish an appropriate institutional machinery for dealing with technology transfer transactions. It stated:

> "In order to organize the collection and dissemination of basic information ... and on that basis to formulate and implement appropriate policies concerning transfers of technology, to undertake the evaluation procedures ... for the purpose of arriving at optimal decisions on projects involving a transfer of technology and mechanisms for transfer, and to carry out the sophisticated negotiation required to obtain favourable terms of transfer contracts ... it is necessary for the developing countries to have efficient institutional machinery". (United Nations, 1972:48).

The specific functions that such institutional machinery were to perform concerning the regulation of the flow of technology among member countries, were suggested previously by an intergovernmental agreement reached in Santiago and approved at the 112th plenary meeting of the United Nations Conference on Trade and Development (UNCTAD). Paragraph 3 of the UNCTAD's Resolution 39 (III), mentioned:

> "(The United Nations Conference on trade and Development...)
>
> Invites the developing countries to establish institutions, if they do not have them, for the specific purpose of dealing with the whole range of complex questions connected with the transfer of technology from developed to developing countries, and takes note of the wishes of the developing countries that these institutions should inter alia:
>
> (a) Be responsible for the registration, deposit, review and approval of agreements involving transfer of technology in the public and private sectors;
>
> (b) Undertake or assist in the evaluation, negotiation or renegotiation of contracts involving the transfer of technology;
>
> (c) Assist domestic enterprises in finding alternative potential suppliers of technology in accordance with the priorities of national development planning;

(d) Make arrangements for the training of personnel to staff institutions concerned with the transfer of technology;

4. Invites the developing countries to take the specific measures they deem necessary to promote an accelerated transfer of adequate technology to them under fair and reasonable terms and conditions." (United Nations, 1972)

In view of the proliferation of Brazilian Laws, decrees and executive acts, international conventions and agreements, it seems that even after the INPI was created in 1970, the operational resolutions and instructions of Central Bank of Brazil, were important instruments controlling technology transactions in the country. Perhaps, in the light of a deteriorating balance of payments and an increasing public and private national debt, stressed in section 4.3.2.1, and the United Nation's emphasis on the establishment of an efficient institutional machinery in developing countries specifically for dealing with the technology transfer policies, finally

in September 11, 1975, the Ministry of Industry and Commerce consolidated the Government's policy for the transfer of industrial technology.

The normative act No. 15 of the INPI

consolidated in one document all legislation concerning technology transactions and royalty payments in Brazil. Appendix 2 contains extracts of the normative act governing technology agreements in Brazil.

One of the major objectives of act No. 15 was "to control the contracting of the transfer of technology" providing guidelines for the supplier and recipient, "so that they can adapt the terms and conditions of the agreements to current legal principles, and also therefore to the Government's policy for the transfer of industrial technology and to the economic-financial policy of the country, in whole or in part". (Appendix 2)

The guidelines of the Government's policy for the period between 1975 and 1979 were formally stated in the Second National Development Plan. (Brazil, Presidency of the Republic, 1974) Technology Transfer was expected to play a key role in the modernization of the industrial structure of the country. Among other points, the plan emphasized the importance of acquiring technology for priority sectors of the economy, creating and adapting technology whenever possible, and gradually developing the country's own technological capabilities. It stated:

"In the effort to consolidate a modern

industrial economy by the end of the decade, Brazil will have to face a complex of problems among which the following should be pointed out: the need to create and adapt technology continuously and not merely produce goods, even the most sophisticated; the realization of advance guard projects in spearhead sectors showing Brazil's capacity to master technologies of the highest sophistication in well-defined areas ..." (Brazil, Presidency of the Republic, 1974:35)

"in the technological area it is important to recognize that, in the period under consideration, the bulk of the effort must be directed to updating the technology in a large number of different sectors , bringing to them the benefit of knowledge already existing in developed countries (the so-called "transference of technology" and carrying out greater or lesser adaptions of technology. This by itself is an enormous task ...

Industrial technology:

The technological development of basic industrial sectors of high technological content:

- the electronics industry, in particular computers;
- the capital goods industry;
- the chemical and petrochemical industry;
- the steel and metallurgical industry;
- the aeronautical industry.

In the case of several products of fields of activity in these sectors, there will be need for an effective transfer of technology so that gradually conditions may be developed to have our own technology." (Brazil , Presidency of the Republic, 1974: 136)

Under the consolidated legislation, registration of technology transactions at the National Institute of Industrial Property was made a condition sine qua non for the following purposes:

a) Acquiring foreign exchange remittances related to patents licences, trademarks, and other contracts involving technical assistance and services. These payments were subjected to Central Bank of Brazil's approval and were governed by an executive decree (Brazil, Presidency of the Republic, 1965) which regulated the Laws establishing the fundamental procedures for foreign capital in the country. (Brazil, National Congress, 1962,1964) In general payments for patents, trademarks, manufacturing processes, and formulae varied between one and five per cent of the net income, while remittances for technical assistance and services appeared to depend on the nature of the contract and the importance of the technology in relation to the Government's policy for the specific sector of the economy.

b) Obtaining income tax deductions. Tax deductions pertaining to technology transactions were governed by directive No. 436, from the Brazilian Ministry of Finance (1958). This directive established the maximum coefficients which firms were allowed to claim according to the degree of importance and the type of economic activity. Manufacturers of computers and other office machinery were allowed a three per cent deduction on the gross operating income derived from the licence. In other activities deductions related to patents, technical services and know-how, varied between two and five per cent. Royalties paid for the use of industrial and commercial trademarks in any type of economic activity were elegible for a deduction of one per cent.

c) Satisfying the requirements of the Industrial Property Code. (Brazil, National Congress, 1971). According to this code, licencees of patents and trademarks had to submit evidence of regular use of the patent or trade-mark - every year. If they failed to comply with these requirements, or if the patent or trademark were not worked within two years of issue, the National Institute of Industrial property could release them as compulsory licencing to interested parties.

4.4.4 THE CLASSIFICATION OF THE AGREEMENTS

For the purposes of registration at the National Institute of Industrial Property, agreements involving technology transactions were classified under five categories, as follows:

a) Licencing agreements for the exploitation of patents. Refer to agreements involving technology for the design of products, manufacturing processes, formulae, etc.

b) Licencing agreements for the use of a trademark. Refer to agreements pertaining to trade-marks, marketing or publicity slogans, etc.

c) Licencing agreements for the supply of industrial technology. Refer to agreements concerning the supply of technology, such as knowledge, special skills, and know-how, for the production of consumer and intermediary goods.

d) Agreements for technical-industrial co-operation. Refer to long- term agreements providing technology, knowledge, know-how and other special skills and services for the manufacture of capital goods such as complete industrial units, machines, equipment, and components.

e) Agreements for the supply of specialized technical services. Refer to the short-term supply of technology, such as managerial and engineering skills for appraisal, planning, programming, controlling and supervising industrial projects.

This classification of technological agreements was derived for INPI's administrative aims of evaluating, registering and monitoring each transaction separately. Its generalization for theoretical purposes seems to be rather limited, taking into account that most technological transactions nearly always involve a combination of technologies in the form of capital goods, intermediary goods, human expertise, and information. (United Nations, 1972) For instance, the technologies associated with the construction of industrial projects in industrialising countries generally utilize a mix of patented and unpatented technologies for the preparation of feasibility studies, the supply of machine and inputs for production, tranining of engineering and managerial personnel, etc.

Considering INPI's taxonomy for technological contracts above there seems to be a common factor present in all categories which will allow a further break-down of the original classification into two general groups of contracts. Taking INPI's classes of contracts and arranging them according to whether they refer to "patented" or "unpatented" technology it is possible to class contracts into the following groups:

1. Contracts involving Patented Technologies

1.1 Patent Licensing Agreements

1.2 Trade-mark Licensing Agreements

2. Contracts involving Unpatented Technologies

2.1 Agreements for the supply of Industrial Technology

2.2 Agreements for technical-industrial co-operation

2.3 Agreements for specialized technical services.

As from July 1, 1978, "in view of the frequency with which contracts which do not conform to the relevant legal and normative provisions are submitted" the INPI instituted a system of prior consultation in negotiations for technology transfer transactions. (INPI, 1978) According the this system, the supplier and recipient should submit in advance to INPI their proposals for entering into agreements involving technology transfer transactions. The application for prior consultation should be made through:

a) The completion of a standardized questionnaire providing the general details of the proposed agreement between the parties

b) The inclusion of a draft of the proposed contract, prepared in parallel columns, in Portuguese and in the foreign language chosen by the supplier.

With the exception of short-term specialized technical services agreements up to US$ 20,000, prior consultation was made obligatory for all categories of contracts involving remuneration referred to in item 1.1 of INPI normative act No. 15.

4.4.5 TECHNICAL-INDUSTRIAL CO-OPERATION AGREEMENTS

In this section, the salient features of the legislation pertaining to agreements of technical-industrial co-operation will be examined. The basic principles and conditions for registering these type of contracts at INPI were established by articles 1 and 5 of the consolidated legislation included in appendix No. 2.

The INPI'S consolidated legislation adhered to the 'national treatment' principle of the Paris Convention, under which nationals and non- nationals are basically given the same treatment under the law. However, there is one special provision which takes into account the degree of ownership control in the technological transactions made between parent and subsidiary organizations.

Article 1.2 refers to the extent to which the supplier of technology participates in the capital structure of the recipient company. It considers three situations of ownership control, defined as total control, majority participation and minority participation. This categorization seems to be particularly important in view of article 20 of the Executive Act No. 55.762, regulating the registration of foreign capital in Brazil, which states:

> "Article 20 - There shall not be permitted remittances for payment of royalties for the use of patents and industrial or commercial trademarks between a branch or subsidiary of a company, located in Brazil and its head office abroad or when the majority of the capital of the company in Brazil belongs to those receiving the royalties payments abroad (Law 4.131, Art 14).
>
> Sole Paragraph - For purposes of this Executive Act, there is considered a subsidiary of a foreign company, a juridical person established in the country, of whose capital with the right to vote at least 50% (fifty per cent) belongs, directly or indirectly, to the company with head office abroad" (Brazil, Presidency of the Republic,

1965).

According to Biato, (1973) this legal restriction on remittances of royalties by subsidiaries of foreign companies in Brazil to their head office abroad was responsible for the elevated number of "Technical assistance" contracts found in his analysis of technology transfer transactions in Brazil between 1965 and 1971. The results of his study indicated that long-term technical assistance contracts, represented 47 per cent of the total, while contracts involving royalties and trade-marks totalled only 24 per cent, and other types of contracts pertaining to short-term agreements for engineering services and project management reached 29 per cent. His study suggested that since the legislation was restrictive in relation to royalties and trade-marks, and since the INPI's administrative machinery was dilatory, subsidiaries of foreign companies found it easier to characterize their payments for technology as technical assistance, rather than patent or trade-mark remittances.

The main objective of technical-industrial co-operation agreement is to acquire "knowledge, know-how and services required for the manufacture to order of industrial units and sub-units, machines, equipment and corresponding components and other capital goods". According to the conditions established for this type of contract, the supplier must provide for the recipient" all the technical data, drawings and engineering specifications for the "product and the materials used for its manufacture, as well as all the methodology of the technological development employed to obtain the same". Besides the provision for the supply of technical data for up-dating the product, the agreement must also include training of personnel and technical assistance by supplier's technicians.

In line with the Government industrial strategy established in the Second National Development Plan, (1975 - 1979) which emphasized the need for an effective transfer of technology for selected sectors of the economy, (Brazil, Presidency of the Republic, 1974) the INPI stressed the basic principles under which foreign technologies would match the governmental intentions as follows:

a) In relation to national alternative sources, the technologies should be of a superior quality and bring, in the short term, benefits to the specific economic sector.

b) The technologies should allow the substitution of imports and, eventually, the export of those same products.

In relation to the remuneration Article 5 stresses that it should be "linked to the actual manufacture of the product resulting from the application of the technology", such as a proportion of the net sales price, or if alternatively based on a fixed price it should be calculated "on the basis of cost plus fixed fee". According to the terms of the agreement, payments may be made "either in one lump sum or in instalments, by means of a duly legalized invoice issued by the supplier, evidencing the remittance of the technical documentation" (Article 5.3.3). In general, these instalments vary between 1 and 5 per cent of the net sales prices and lump sums are authorized depending upon the importance of the technologies involved in relation to the priorities of the governmental policies for the sector.

In respect to the duration of the contracts, article 5.4.1 establishes an initial maximum period of five years "which may be extended". This article also stresses the pro tempore nature of the contractual bond concerning the transmission of technologies for the manufacture of capital goods. Although it is not clear how many times the contracts, may be extended, the recipient should present a chronogram of the activities and resources needed "to reach a position of being able to master the technology". This assumes that the recipient is in a position to evaluate the requirements of the technology transfer process in terms of time, resources and skills needed to accomplish the desired results. As a United Nations (1972:5) study stated, generally recipients "are not fully aware of the nature and the components of the acquired technology-mix". Thus, the ability of the receiving parties to anticipate the requirements of the technology transfer process seems to be limited. A possible exception concerns those circumstances where both the supplier and recipient firms are able to benefit from learning economies (Arrow, 1962) derived from previous experiences in Technology Transfer processes.

Other basic conditions stipulated for agreements of technical-industrial co-operation are included in article 5.5. Item 5.51 details a list of topics which should be included such as a clear definition of the field of application of the technology, the product, techniques, resources and documentation involved, and the means designed to transmit those, income tax liability, and other responsibilities and obligations for the parties. Conditions which should be avoided in the elaboration of contracts are listed in item 5.5.2. Among those, the identification of the proprietary rights of the supplier, the obligation for the recipient to pass on to the suppliers any improvements made in the tecnology, the inclusion of clauses which determine the source of inputs, the quantity, quality, means of distribution, marketing or destiny of the products of services involved, post-termination clauses which may prevent the recipient from continuing to use the technology after the termination of the contract, and other provisions which may limit the development potential of the recipient.

5. OVERVIEW OF THE COMPUTER MARKET

5. OVERVIEW OF THE BRAZILIAN COMPUTER MARKET

5.1 INTRODUCTION

This chapter intends to provide an overview of the evolution of the computer market in Brazil in the period 1970-1980. It consists of two major sections. Section 5.2 presents some aspects of computer technology. Section 5.3 is subdivided into three subsections. Section 5.3.1 provides an overview of the Brazilian computer market. Section 5.3.2 presents the evolution of the installed computer base. Section 5.3.3 identifies the main institutional mechanisms for Government intervention in the market.

5.2 COMPUTER TECHNOLOGY

Although the first electronic computer became available in the fourties, the history of computer technology seems to go back to ancient civilizations. The Chinese performed calculations by sliding counters along rods. The abacus Pythagoricus developed in ancient Greece, was basically an instrument for arithmetical computations utilizing small balls sliding on wires placed at different levels for representing different numerical values in units, tens, hundreds, etc. Based on the abacus, in the mid-seventeenth century, Blaise Pascal, a French mathematician built a mechanical device to add and subtract by digits. Later, in the same century, Leibnitz constructed a machine which was able to perform multiplication of numbers using the method of successive additions. In the early part of the eighteenth century, Bouchon introduced the idea of a punched card for the purpose of storing numbers. In the early nineteenth century, Charles Babbage, an Englishman, designed the 'analytical engine' which included six digits for calculations and some features of today's modern computers, such as a memory for storage and retrieval of data to be used in subsequent computations. Because of the revolutionary concept of internal memory, Babbage's machine might have been the first computer. (Mayall, 1980).

According to Turn, (1974:6) computer technology is the "totality of means, devices, processes and techniques employed in the construction and operation of digital computers". This broad conceptualization of computer technology embraces the elements of technical knowledge, intermediary goods, computer hardware and software techniques, and fabrication processes involved in the construction of computers. In the Organization for Economic

Co-operation and Development's (OECD, 1969) view, computer technology is interdisciplinary in nature, and derives from three closely interdependent, mutually interacting sources, as follows:

a) COMPUTER SCIENCES. These form the theoretical basis of knowledge for instance, cybernetics deals with the study of control and communication between man and machines. Other examples are robotics, numerical analysis, pattern recognition, language analysis, material sciences, etc.

b) COMPUTER ENGINEERING TECHNOLOGY. Deals with computer hardware and software design. It involves logic design, systems design, peripheral equipment design, computer-aided design, etc.

c) COMPUTER USAGE TECHNOLOGY. It involves data handling methods, such as statistical analysis, data transmission, information storage, etc and various kinds of computer applications such as commercial data processing, scientific calculations, industrial processing control, navigation and tracking, military weapon control systems, etc.

During the second world war, the research into computer technology was intensified in England, Germany and the United States. Among the envisaged projects were the development of anti-aircraft guns which would be able to calculate the trajectory of the enemy's plane and activate the firing system; the development of software for automatic flying of military airplanes; the programming the trajectory of the missiles, the decoding of the enemy's message etc. These intended war applications seem to provide an illustration of the multidisciplinary aspects of computer technology referred by the OECD. For instance, the development of computers able to calculate the trajectory of a plane and destroy a moving target involves capabilities and knowledge in diverse fields such as mathematics, electronics, mechanics, physics, and particularly aerodynamics, etc.

The development of computer technology seems to be closely linked and dependent, among other things, upon technological advances in the electronic component industry. According to the Economist Intelligence Unit, (EIU, 1979a) since the invention of the integrated circuit in the early sixties, there has been a progressive miniaturization of electronic components, accompanied by an impressive reduction in cost. In the early sixties, tens of electronic elements (SSI - small scale integration) were manufactured together on semiconductor material, such as silicon. In the end of the sixties, hundreds of components were associated on to small circuits (MSI - Medium Scale Integration). In the late seventies, thousands of electronic elements were compacted together in single circuits, or chips. (LSI - Large Scale Integration). In Amdahl's (1978) view in the eighties more than one million electronic components will be compacted in a single chip. (VLSI - Very Large Scale Integration). Commenting on the main structural forces affecting the computer industry, Amdahl stated:

> "There are significant forces at work - hardware technology in computers and communications on the one hand, and reactive forces from a large number of emerging applications on the other. All of this, of course is nurtured by the intermediary - software - and by an impatient set of prospective users.
>
> The most dramatic force is the fervent pace of semiconductor technology. Data processing continues to reap its own harvest from

> advances in semiconductor technology... Microprocessors now abound in terminals, peripheral controllers, communication devices, and small standalone computers. Semiconductor memories are rapidly improving the price/performance characteristics of computers of all sizes". (Amdahl, 1978:18).

COMPUTER GENERATIONS

Sometimes the expression computer generation seems to be utilized for associating computer technology with the level of technological development of the components which were utilized to manufacture the computers. (U.S. Department of Commerce, 1973, 1976; Withington, 1972; Bromberg, 1978; Baranson, 1979). However, considering that computer technology involves a variety of elements such as hardware design, software design, mechanical, electrical and electromechanical components, among other things, a categorization of computers based solely on component technology does not take into account technological advances in the other fields. (OECD, 1969). Thus, keeping this restriction in mind, the following generations of computers can be distinguished:

a) THE FIRST GENERATION. During the fourties and early fifties, the first generation vacuum tube computers were relatively slow in terms of processing speeds, had limited storage capacity, were extremely expensive, occupied large amounts of space and were mostly used by government agencies and large organizations.

b) THE SECOND GENERATION. With the invention of the transistor in 1947, by a group of scientists of the Bell Telephone Laboratories, (Tilton,1971) in the late fifties and early sixties, the transistorized second generation of computers appeared in the market. In general, the application of transistor technology, led to the design of computer hardware with greater storage capacity, a broader range of applications, more reliability, faster speeds and a more accessible price of the product in the market.

c) THE THIRD GENERATION. By the mid sixties further advances in electronics, particularly in the integrated circuit technology, enabled computer manufacturers to develop larger and faster memories, to reduce the size of the machines, to offer a better performance/price ratio, a wider range of software, modularity in design and time-sharing and multiprogramming capability.

d) THE FOURTH GENERATION. In the seventies, the increasing miniaturization of electronic components in single circuits, the progressive reduction in cost per microelectronic component, among other factors, led manufacturers to offer computers with large-scale integrated circuitry, large memories, teleprocessing capabilities, improved software options, increased computer speed, better price/performance ratio, etc.

e) THE FIFTH GENERATION. According to Japan's Interim Report on study and Research on Fifth Generation Computers, (JIPDEC, 1980) the next generation of computers will be characterized by radical changes in hardware and software technologies. The fundamental change envisaged involves a new concept in computer design. Computers are intended to be knowledge processing machines, rather than simply data processing devices in the sense formulated by Von Neumann and his associates (1946). The major anticipated features of the knowledge information processing machines are a high level of man-machine interface, such as conversational input media, and the computer system's ability to extract meaning from the information. International Business Machines (IBM) also seems to be planning for the fifth generation of computers. Recently, IBM's secret plans for the next generation of machines, known as the 'Adirondack Hardware Design Workbooks' were the object of a high technology espionage case against Hitachi associates, filed in the Federal Court in San Jose, California by the United States Federal Bureau of Investigation, (Wiener, 1982).

THE CLASSIFICATION OF COMPUTERS

In view of the rapid rate of technological change in the computer sector (European Business, 1974; Withington, 1972, 1975, 1978; Houston, 1973: Amdahl, 1978), there seems to be no universally accepted criterium for classifying computers into categories. The pace of technological change in computers seems to be so dynamic that "today's minicomputers could really be classified as giant mainframes of the past" (Bromberg, 1978).

In addition, there seems to be no agreement on what a minicomputer is. For instance, some experts conceptualize "minicomputers" in terms of their price, physical size, storage capacity, range of applications, software capabilities, etc. They state:

> "Minicomputer is ... a range of small to medium scale digital computers" (Healey, 1976:226)

> "... a machine developed primarily for the processing of a single application or the processing of a number of small applications" (Bromberg, 1978:98).

> "A 'micro computer' is a small computer having very little main store, a somewhat limited order code and very few peripherals, whilst a "minicomputer" is a bit bigger, has

more store, more order code, and more expensive peripherals" (Minicomputer Forum, 1975:2).

"The minicomputer is nothing more than a small, low-cost general purpose computer. ...The smallness relates to both physical size as well as limits on word size, storage capacity, registers, instruction repertoire, and software. The low cost relates to basic minicomputer prices that range from US$ 2,000 to US$ 50,000." (Frost and Sullivan, 1974: 13-14).

Although there appears to be no absolute criterium for classifying computers into categories, in recent years, there has been a trend towards categorizing computers from a marketing point of view, rather than hardware or pricing parameters. (EDP Industry Report, 1980). Frost and Sullivan, for instance, suggest that minicomputers should be classified by the manner by which they are supported and marketed. (Frost and Sullivan, 1980).

CAPRE'S CLASSIFICATION

In the remaining part of this chapter, most of the quantitative data utilized for analyzing the general characteristics and the evolution of the Brazilian computer market, derived from the Commission for Co-ordinating Electronic Data Processing Activities (CAPRE, 1977, 1979). Between 1972 and 1979, as the Governmental Agency responsible for the computer sector, CAPRE had access to the total number of organizations using computers in Brazil, both in the private and public sectors. As from 1974, CAPRE developed periodic assessments of the installed computer capacity, by sending questionnaires directly to users of computer systems and compiling the results in a census. The criterium adopted by CAPRE for categorizing computers by size was the price range of the central processing unit and main memory, defined as follows:

a) MINICOMPUTERS. Price range: Less than US$ 30,000.

b) SMALL COMPUTERS. Price range: Between US$ 30,000 and US$ 180,000.

c) MEDIUM COMPUTERS. Price Range: Between US$ 180,000 and US$ 600,000.

d) LARGE COMPUTERS. Price range: Between US$ 600,000 and US$ 1,200,000.

e) VERY LARGE COMPUTERS. Price range: Over US$ 1,200,000.

5.3 THE COMPUTER MARKET

5.3.1 AN OVERVIEW OF THE MARKET

THE MARKET IN 1972

A U.S. Department of Commerce Global Market survey of computer equipment conducted in eighteen countries, stated:

> "Brazil is now showing enthusiasm for advanced technology, particulary in the field of computers. The move of many government departments to the new capital city of Brasilia occasioned major reorganisations, and computers are part of the new administrative structure. Massive investments in Brazil's infrastructure have led to unprecedented growth in capital spending by power and telecommunication utilities and engineering and construction firms, resulting in a sharp rise in demand for new and improved machinery and equipment, including EDP and related equipment. Widespread prosperity among medium-size commercial and industrial firms in the

central and southern regions has created a market for smaller computers". (U.S. Department of Commerce, 1973: 26)

At that time Brazil's economy was experiencing unprecedented rates of growth, leading to rising demand for computers in many sectors. Between 1968 and 1973 the real Gross Domestic Product averaged approximately a ten per cent annual growth rate. Industrial real output achieved a 15.9 per cent annual growth in 1973, and for the first time in many years, the balance of trade achieved a surplus of US$ 7 millions. As it was suggested by the Financial Times, (1979) an "economic miracle" was being performed in the economy of Brazil, in terms of quantitative indicators of economic growth.

The main conclusions reached by the U.S. Department of Commerce study were:

a) The growth prospects of the computer and related equipment market, in many countries, were higher than those of the United States.

b) About 90 per cent of the world market was being supplied by U.S. companies, their foreign subsidiaries and licensees. This represented an enormous advantage for U.S. manufacturers in terms of compatibility of equipment, hardware and software technology.

c) The worldwide market was expected to grow at an average rate of 25-30 per cent during 1973 and 1977 and the highest growth rates were anticipated in the field of minicomputers, data communications and peripheral equipment.

d) As shown in Table 5.1, the total market for computers and related equipment in eighteen countries surveyed was estimated at US$ 5,353.5 millions in 1972. The projections for 1977 reached US$ 18,842.9, representing a percentage change of 251.9. In terms of growth prospects of the individual countries, Japan was expected to expand the value of its computer market by (498) per cent between 1972-1977, followed by Brazil (271), Israel (240), Spain (211), Belgium (201), France (163), Italy (153), Yugoslavia (142), Australia (128), Norway (121), Mexico (114), Switzerland (107), Germany (107), United Kingdom (104), Venezuela (97), Sweden (94), Netherlands (85) and Denmark (38) per cent.

TABLE 5.1

TOTAL MARKET FOR COMPUTERS AND RELATED EQUIPMENT IN 18 COUNTRIES, 1972 AND PROJECTED 1977

(In US$ Millions)

Country	Value in 1972	Projected 1977	Percentage Change
Germany	1,268.4	2,627.2	107
Australia	83.0	190.0	128
Belgium	136.1	410.0	201
Brazil	50.7	188.3	271
Denmark	57.0	79.2	38
Spain	106.8	332.5	211
France	693.0	1,823.0	163
United Kingdom	454.0	926.2	104
Netherlands	164.5	305.3	85
Israel	10.1	34.4	240
Italy	222.8	564.1	153
Japan	1,791.4	10,713.2	498
Mexico	30.0	64.2	114
Norway	20.5	45.5	121
Sweden	126.2	246.0	94
Switzerland	106.6	221.4	107
Venezuela	13.6	26.8	97
Yugoslavia	18.8	45.6	142
	5,353.5	18,842.9	251

Source: U.S. Department of Commerce (1973)

Table 5.2 presents the U.S. Department of Commerce main estimates and projections for the Brazilian Computer market. According to them, the market for computers and related equipment in Brazil was worth US$ 23.7 millions in 1970, US$ 39.0 millions in 1971 and US$ 50.7 millions in 1972. The projections for 1973, 1974 and 1977 were US$ 65.9, 85.7 and 183.3 millions respectively. The aggregate growth of the market in the period 1970-1977 was calculated as 694 per cent.

In relation to the value of the minicomputer segment of the market, table 5.2 indicates that it grew 200 percent between 1970-1971 and 104 per cent between 1971-1972, while small, medium and large computers increased only by 58 per cent and 24.3 per cent during the same periods. Thus, according to these figures minicomputers were growing faster than any other segment of the market.

Their research also suggested that approximately 57% of the minicomputers installed in Brazil in 1972 were being used in the industrial and transportation sectors, 28% in the commercial sector and 15% concentrated in government departments and educational establishments.

In terms of applications by fields of activity, prospects for minicomputers were anticipated

TABLE 5.2 THE VALUE OF THE BRAZILIAN MARKET FOR COMPUTERS AND RELATED EQUIPMENT, 1970-1972 AND PROJECTED 1973-1977 (in US$ Millions)

EQUIPMENT/YEARS	1970	1971	1972	1973	1974	1977
MINICOMPUTERS	0.8	2.4	4.9	6.4	8.3	18.1
SMALL, MEDIUM AND LARGE COMPUTER SYSTEMS	22.9	36.2	45.0	58.0	75.4	164.7
PERIPHERAL EQUIPMENT	-	0.2	0.5	1.0	1.3	3.2
DATA TRANSMISSION EQUIPMENT	-	0.2	0.3	0.5	0.7	2.3
TOTAL	23.7	39.0	50.7	65.9	85.7	188.3

Source: U.S. Department of Commerce (1973) in the scientific and process control areas, despite their "developing but limited market". An apparent demand was also identified for the use of minicomputers as intelligent terminals for larger computer systems, and as programable, front-end processors in data communication systems. As regards the application of minicomputers in management, the prospects were summarized as follows:

> "The market for minicomputers for use in business management applications is more than doubling each year, according to trade sources. Small and medium size firms comprise the bulk of Brazil's industrial and commercial sectors, and minicomputers offer these firms an attractive solution to their mounting paperwork problems". (U.S. Department of Commerce, 1973:24).

THE MARKET IN 1976

According to the Commission for Electronic Data Processing Activities, (CAPRE) in July 1976, there were 5078 computers installed in the country and 20 suppliers of computer systems operating in Brazil.

These suppliers of computers ranged from small sales subsidiaries to very large, diversified manufacturers. CAPRE's assessment of the market share by manufacturers, in terms of the value of the systems installed, suggested that the market was dominated by major international companies in the computer sector. For instance, one company, International Business Machines, (IBM) concentrated 63.6% of the market, followed by Burroughs (20.2%); Honeywell (4.2%); Univac (3.6%); Olivetti (1.7%); NCR (1.5%); DEC (1.4%) and others (3.8%).

In terms of value of the segments of the market according to CAPRE's estimates in 1976 very large computers represented 30.6% of the total market, small computers (23.3%), medium computers (22.4%), large computers (15.2%) and despite the large numbers of minicomputers installed, this segment was evaluated as only 8.5% of the total market value.

In 1976, CAPRE also investigated the total amount of investments and expenditures in data processing activities in Brazil. As shown in Table 5.3 the public sector accounted for 45% of the total expenditure, while the private sector was responsible for 55%. Within the public sector, very large installations were the predominant segment with 52.2%, while minicomputers accounted for only 12% of the

TABLE 5.3 BRAZIL's EXPENDITURE IN DATA PROCESSING BY SIZE OF THE INSTALLATION AND SECTOR, 1976

SIZE	BRAZIL CR$	BRAZIL %	PUBLIC SECTOR TOTAL = 7.094.354 %	PRIVATE SECTOR TOTAL = 8.461.782 %
VERY LARGE	5,824,616	37.4	52.2	25.1
LARGE	1,398,925	9.0	5.7	11.8
MEDIUM	2,732,155	17.6	15.1	19.6
SMALL	2,894,599	18.6	10.8	25.1
MINI	1,757,404	11.3	12.0	10.7
OTHER	948,437	6.1	4.2	7.7
TOTAL	15,556,136	100	100	100

Source: Capre (1979)

expenditures and investments. In the private sector, the largest amounts were concentrated on the very large and small segments, each of which had 25% of the total. Minicomputers had a 10.7% share of the total amount, while medium and large computers accounted for 19.6 and 11.8 respectively. Considering the private and public sectors at the same time, very large installations spent 37.4% of the total amount, while minicomputers totalled 11.3%.

A breakdown of the expenditures by kind of activity and sector indicated that the industrial users were the second largest user category with almost 30% of the market (Table 5.4). The largest user group were computer bureaux of data processing services, with 35% of the total amount spent on data processing. This category, however, includes suppliers of equipment which also provide service to clients, such as IBM, Burroughs and Olivetti. The financial sector, which was mostly made up by the State and private Banks, accounted for 14.2% of total expenditures. Private Banks represented approximately two thirds of the total amount. Teaching and research showed a limited share of the expenditures (3.8%) suggesting restricted allocation of financial resources for data processing activities at the universities and research

TABLE 5.4 BRAZIL'S EXPENDITURE IN DATA PROCESSING BY KIND OF ACTIVITY AND SECTOR, 1976.

ACTIVITY/SECTOR	BRAZIL CR$	BRAZIL %	PUBLIC SECTOR Percentage	PRIVATE SECTOR Percentage
INDUSTRIAL	4,543,153	29.2	14.4	41.6
FINANCIAL	2,206,014	14.2	11.0	16.9
COMMERCE & SERVICES	2,364,720	15.2	14.4	15.8
TEACHING & RESEARCH	593,879	3.8	6.9	1.3
BUREAU/CONSULTANCY	5,444,194	35.0	47.6	24.4
OTHER	404,176	2.6	5.7	
TOTAL	15,556,136	100	100	100

Source: Capre (1979)

institutions.

A further breakdown by activity, aggregating both sectors of the economy, revealed that "Bureau/Consultancy" accounted for over thirty per cent of total investment and expenditures in Brazil in 1976. (Table 5.5) Commercial Banks accounted for 12.16%; public utilities 5.23%; metallurgy 4.44%; electrical and communication material 3.92%; computer suppliers 3.77%; commerce 3.55%; teaching 3.21% and research for 0.60%. These activities, taken together, represented over two thirds of Brazil's expenditure on data processing in 1976.

THE MARKET IN 1978

In 1978, an estimated 6641 computers had been installed in Brazil. According to DIGIBRAS, the Brazilian domestic computer market was worth US$ 340 millions, or the equivalent to 0.9% of the world market for computers and related equipment. (US$ 37,300 millions). In July 1978 there were 21 manufacturers of computer systems represented in the Brazilian Computer market. These can be divided into the groups as follows:

a) FOREIGN MANUFACTURERS. These consisted of

TABLE 5.5

BRAZIL'S DATA PROCESSING EXPENDITURES BY ACTIVITY, 1976

Source: Capre (1979)

ACTIVITIES	PERCENTAGE
BUREAU/CONSULTANCY	30.54
COMMERCIAL BANKS	12.16
PUBLIC UTILITIES	5.23
METALLURGY AND SIDERURGY	4.44
ELECTRIC AND ELECTRONIC ENGINEERING	3.92
COMPUTER SUPPLIERS	3.77
COMMERCE IN GENERAL	3.55
TEACHING	3.21
MINERAL EXTRACTION	2.43
VETERINARY	2.22
ADMINISTRATIVE CONSULTANCY	2.19
FOODSTUFFS	2.10
MECHANICAL	2.03
CIVIL CONSTRUCTION	1.96
GENERAL SERVICES	1.85
ELECTRICAL ENERGY AND GAS	1.60
CHEMICALS	1.60
TRANSPORTS	1.47
PAPER AND CARDBOARD	0.96
TRANSPORTATION EQUIPMENT	0.87
TEXTILES	0.76
STOCK MARKET FIRMS	0.64
RESEARCH	0.60
OTHER	9,86
TOTAL	100.00

large companies with worldwide reputation, capital, technological resources and historical experience in the development, production and marketing of computers. IBM, Burroughs, Honeywell-Bull, Univac, Olivetti, Phillips, Hewllet-Packard, Digital, NCR and ICL represented the largest section of the market with over 95% of the installed computer base in 1978.

b) BRAZILIAN MANUFACTURERS. These consisted of Cobra and Sisco, a newly formed independent company which was manufacturing computers compatible with Data General's Nova 3 model. In July 1978, Cobra and Sisco's estimated share of the market were 0.7 and 0.2% respectively.

Table 5.6 presents the market share by manufacturer, in terms of the number of systems installed. CAPRE's survey in mid-1978 revealed the following results by segment of the market:

a) Very large computers. This segment of the market was dominated by Burroughs (23.7%) and IBM (72.0%) the other two suppliers were Control Data (1.1%) and Honeywell-Bull

TABLE 5.6 MARKET SHARE BY MANUFACTURER AND SIZE OF THE INSTALLATION, 1978 (NO. OF SYSTEMS)

MANUFACTURER	VERY LARGE	LARGE	MEDIUM	SMALL	MINI	PERCENTAGE OF TOTAL
	%	%	%	%	%	%
Burroughs	23.7	5.4	26.8	12.5	32.8	27.4
Cobra					1.0	0.7
Commicromation					0.9	0.6
Control Data	1.1					
Data General				0.9	0.3	0.4
Digital			0.8	13.1		2.8
Facom		1.2	3.8	1.5	0.1	0.6
HP				7.4	4.7	4.8
Honeywell-Bull	3.2	3.6	13.3	3.9		1.7
IBM	72.0	85.0	45.4	53.7		16.8
ICL				2.0	0.3	0.6
NCR		1.8	1.6	0.4	5.8	4.3
Olivetti					44.7	31.2
Philips					6.0	4.2
RUF					1.4	1.0
Sisco					0.3	0.2
Thomson			0.5	0.8		0.2
TRW					0.8	0.6
Univac		3.0	7.8	3.8		1.3
Varian					0.5	0.3
Wang					0.4	0.3
TOTAL	100	100	100	100	100	100

Source: Capre (1979)

(3.2%). There were only 93 very large installations in Brazil and this segment corresponded to only 1.4% of the total market in terms of the number of installed computers.

b) Large computers. A total of 166 large computers were installed in Brazil in 1978, representing 2.5% of the computer base at that time. Within this segment, IBM had its largest share of the Brazilian market (85%). Other suppliers and their relative market share were: Burroughs (5.4%); Honeywell-Bull (3.6%) Univac (3.0%); NCR (1.8%) and Fujitsu (1.2%).

c) Medium computers. Medium sized computers represented 5.6% of the market, with 370 units installed in mid 1978. Again, IBM's strong position was repeated here with 45.4% of this segment. Burroughs had a relatively strong position (26.8%) being followed by Honeywell-Bull (13.3%); Univac (7.8%); Fujitsu (3.8%); Digital (0.8%) and Thompson (0.5%).

d) Small computers. The 1378 small computers installed in Brazil in July 1978 accounted for 20.7% of the market. Major suppliers and their relative share of the segment were: IBM (53.7%); Burroughs (12.5%); Digital (13.1%); Univac (3.8%) and ICL (2.0%). The remainder of the segment was divided among Data General, NCR and Thompson.

d) Minicomputers. The number of minicomputer systems installed in the country reached 4634 units in July 1978, representing 69.8% of the market. Most major manufacturers were operating in the minicomputer segment in 1978, except IBM, Control Data, Thompson and Univac. Up to July 1978 COBRA had installed 41 units of its "COBRA-400" and 6 units of the "COBRA-700" model, totalling 47 minicomputers. This represented 0.7% of the market. The largest share of this segment was that of Olivetti, the Italian manufacturer with 44.7% of the market, being followed by Burroughs (32.8%); Phillips (6%); NCR (5.8%); Hewllet-Packard (4.7%) and others totalling 6%.

5.3.2 THE EVOLUTION OF THE MARKET

Figure 5.1 shows the evolution of Brazil's installed computer base between 1970 and 1980. An examination of figure 5.1 suggests that the country's installed computer base has evolved considerably between 1970 and 1980. From a total computer population of 574 in 1970 to 8844 units in 1980, the installed computer base grew at an annual rate of over 31.4% in the period.

The data utilized to analyze the evolution of the number of computers in Brazil in the period 1970-1980 derived from three sources. Data for the period 1970-1973 were gathered from DIGIBRAS (Brazilian Digital Electronics) internal documents. Data for the period 1973-1979 were provided by the Brazilian Commission for Electronic Data Processing Activities. Data for 1980 derived from the Special Secretariat of Informatics, the Governmental Agency which took over CAPRE's attributions in the end of 1979. The criterium utilized by these organizations for categorizing computers by size, was CAPRE's price range.

Table 5.7 presents the total number of computers installed in Brazil by size. In the period 1970-1980, minicomputers grew at an annual rate of over

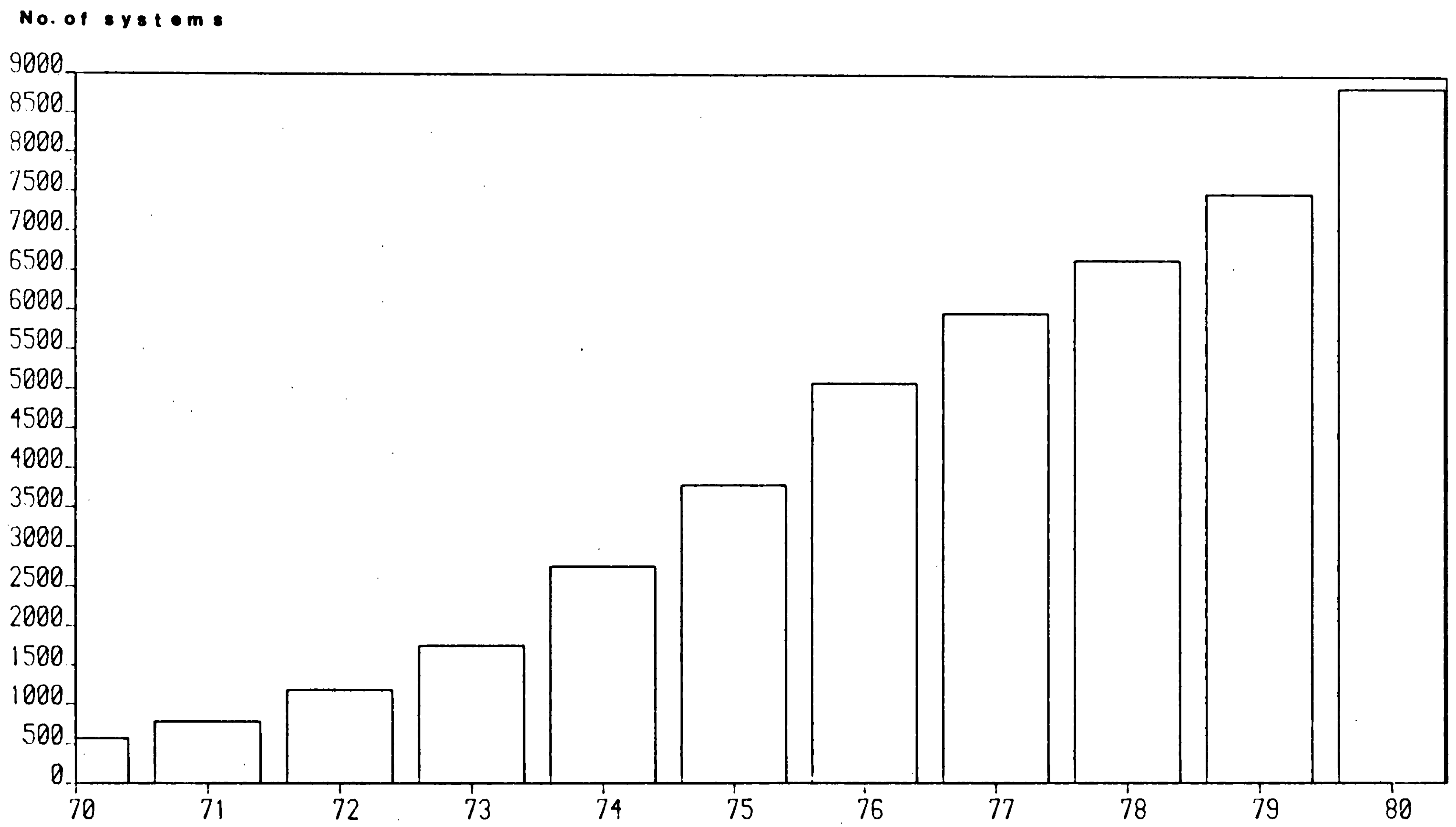


Figure **5.1** - Installed Computer Base - Brazil 1970 - 1980

TABLE 5.7 DISTRIBUTION OF COMPUTERS BY SIZE, BRAZIL

1970-1980

YEAR	SIZE					TOTAL
	MINI	SMALL	MEDIUM	LARGE	V.LARGE	
1970	156	333	68	5	12	574
%	27.1	58.0	11.8	0.8	2.0	100
1971	272	413	70	15	15	785
%	34.6	52.6	8.9	1.9	1.9	100
1972	520	534	79	31	23	1187
%	43.8	44.9	6.6	2.6	1.9	100
1973	920	657	102	46	30	1755
%	52.4	37.4	5.8	2.6	1.7	100
1974	1153	781	289	71	42	2756
%	57.0	28.3	10.4	2.5	1.5	100
1975	2271	1046	327	82	61	3787
%	59.9	27.6	8.6	2.1	1.6	100
1976	3313	1256	338	99	72	5078
%	65.2	24.7	6.6	1.9	1.4	100
1977	4105	1296	353	122	87	5963
%	68.8	21.7	5.9	2.0	1.4	100
1978	4634	1378	370	166	93	6641
%	69.8	20.7	5.6	2.5	1.4	100
1979	5294	1494	377	226	97	7488
%	70.6	19.9	5.0	3.0	1.2	100
1980	6402	1683	388	248	123	8844
%	72.3	19.0	4.3	2.8	1.3	100

Sources: 1970-1973 Brazilian Digital Electronics
1974-1979 Capre
1980 Special Secretariat for Informatics

44.9 per cent, while the aggregate growth of the other segments was approximately 19.3 per cent. Figure 5.2 shows graphically the evolution of the mini, small, medium, large and very large segments of the market between 1970-1980. An examination of table 5.6 and figure 5.2 reveals that, in quantitative terms, the minicomputer segment has been the largest segment of the market since 1973. In 1970, minicomputers represented only 27.1% of the market while small computers held the largest share with 58% of the market. Since 1970, however, the relative importance of minicomputers has been growing, while that of small computers has been decreasing steadily. In 1980 minicomputers represented 72.3% of the number of computers installed in Brazil, small computers (19.0); medium computers (4.3); large computers (2.8); and very large computers only 1.3 %.

The relative importance of minicomputers in the context of the Brazilian computer market is, perhaps, better illustrated in figures 5.3 and 5.4. These figures present isometric projections of Brazil's installed computer base in the period 1970-1980, from four different perspectives. In these figures, the small, medium, large and very large segments of the market have been combined in "other segments". An examination of figures 5.3 and 5.4 suggests clearly

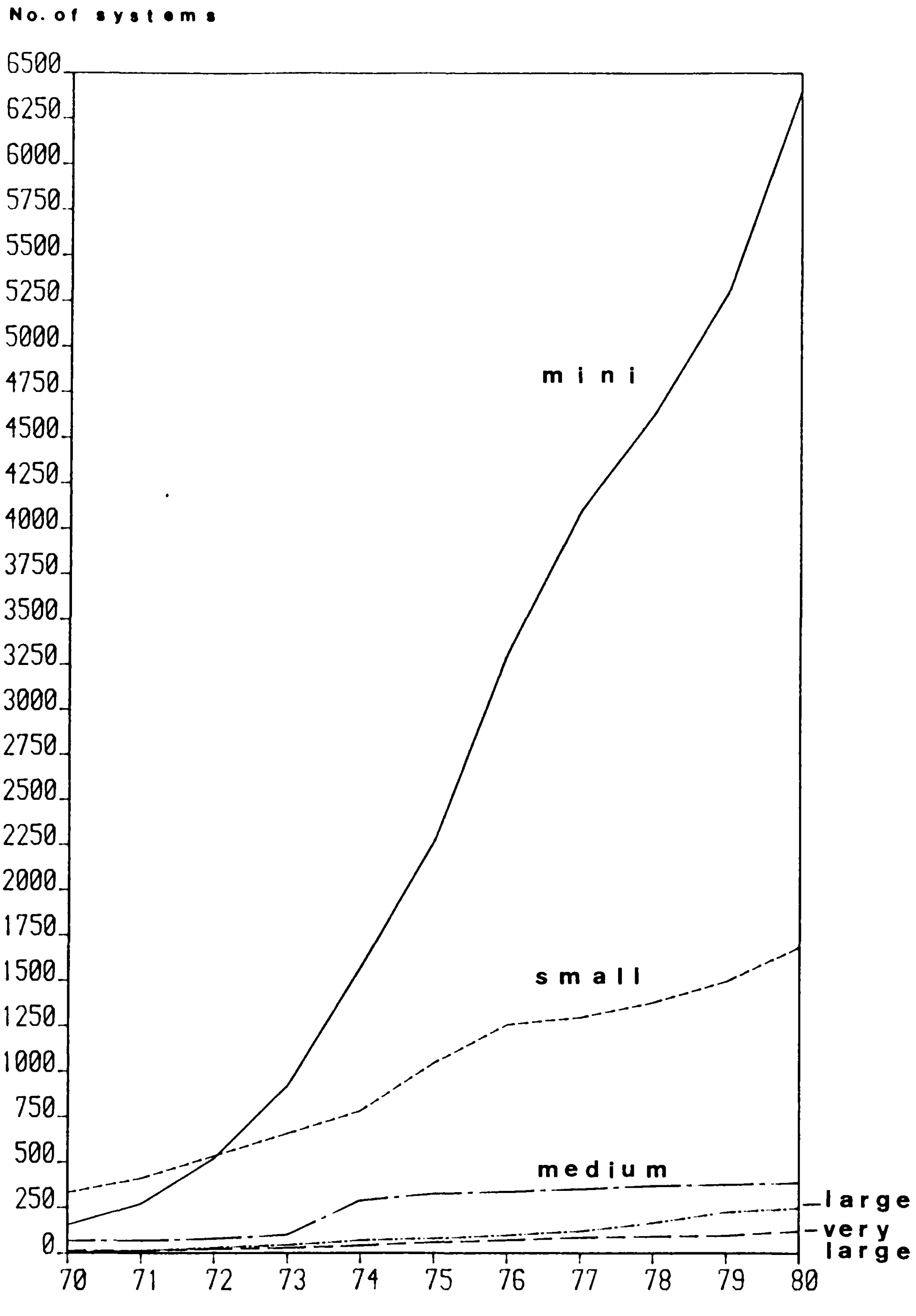
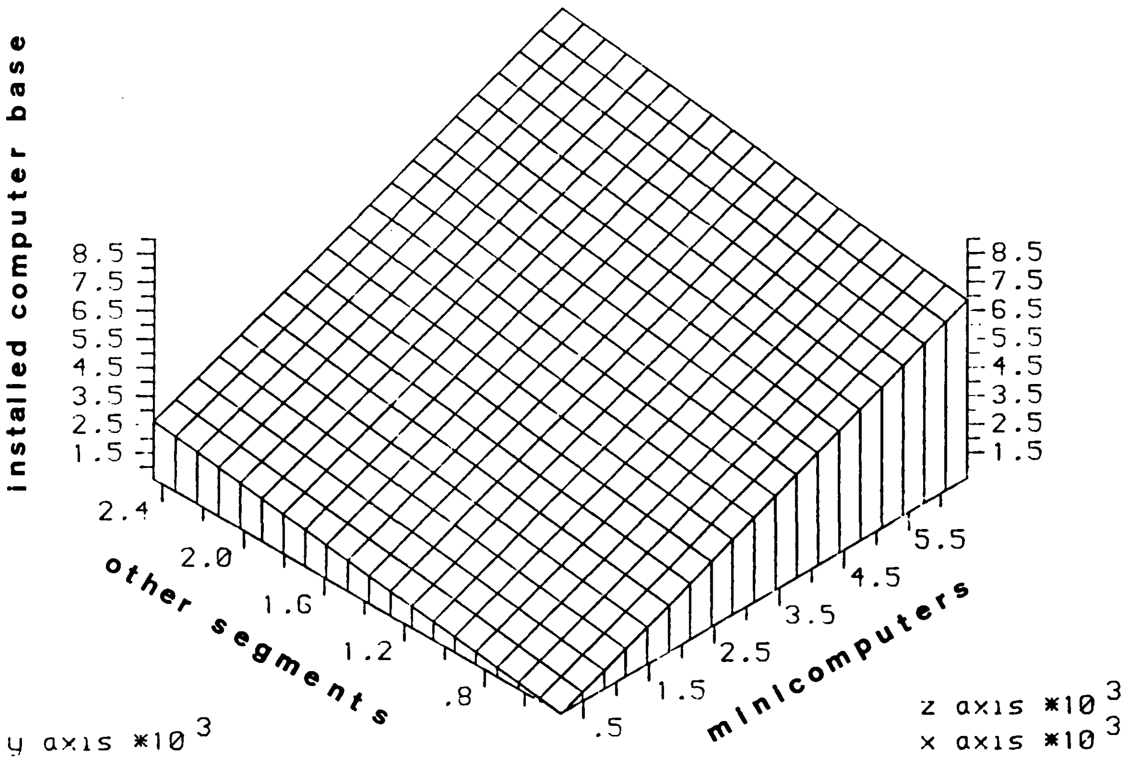


Figure **5.2** Installed Computer Systems by Size - Brazil

Sources : 1970-1973 Brazilian Digital Eletronics

1974-1979 Comission For E.D.P. Activities

1980 Special Secretariat For Informatics



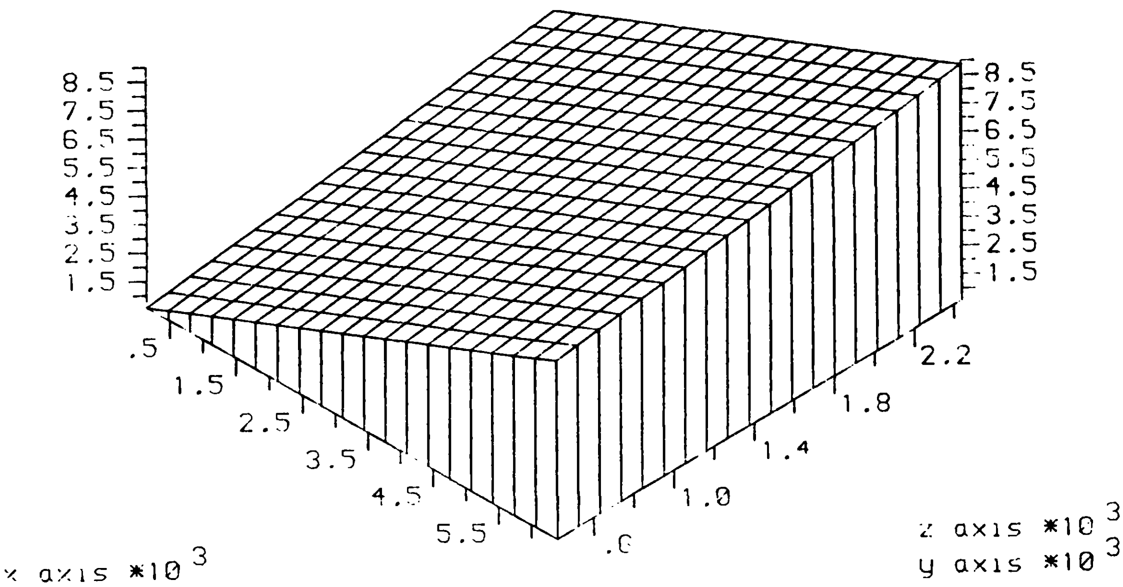


Figure **5.3** Brazil's Installed Computer Base, Minicomputers and Other Segments, 1970 - 1980

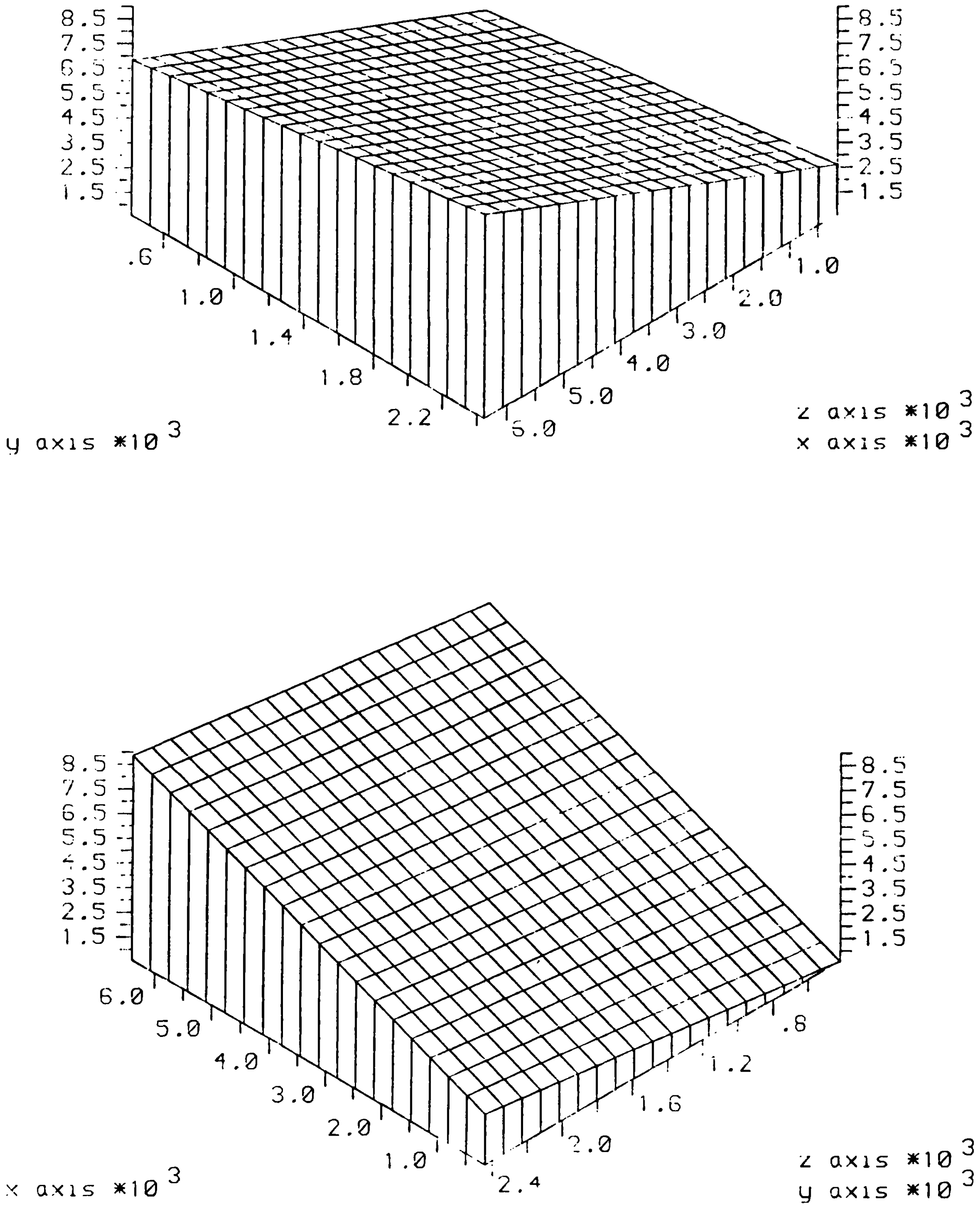


Figure 5.4 Brazil's Installed Computer Base, Minicomputers and Other Segments, 1970 - 1980

that, in the period under consideration, the relative importance of minicomputers exceeded that of all other segments combined.

THE NUMBER OF COMPUTERS AND THE G.D.P.

A United Nations report on the application of computer technology for development suggested that the number of computers installed in a country is related to the country's gross domestic product. Following a survey conducted in several countries they found that there existed a positive relationship between the installed computer base and the G.D.P. levels, both in developed and developing economies. (United Nations, 1971).

In order to test this relationship, a simple linear regression analysis was performed on the data from the installed computer base in the period 1970-1980 (Table 5.7), and Brazil's Gross Domestic Product at 1970 factor cost, calculated by the Economist Intelligence Unit. (Stoneman, 1981) Pearson product-moment correlation coefficient, the associated test of significance, the slope of the regression line and other relevant statistics are summarized in Table

INSTALLED COMPUTER BASE

STATISTICS..

CORRELATION (R)-	0.98406	R SQUARED -	0.96837	SIGNIFICANCE -	0.00000
STD ERR OF EST -	543.88452	INTERCEPT (A) -	-7052.86376	SLOPE (B) -	39.94672
PLOTTED VALUES -	11	EXCLUDED VALUES-	0	MISSING VALUES -	0

'*********' IS PRINTED IF A COEFFICIENT CANNOT BE COMPUTED.

Table 5.8 Statistics, Linear Regression Analysis, Brazil's G.D.P. with the installed computer base, 1970-1980.

INSTALLED COMPUTER BASE

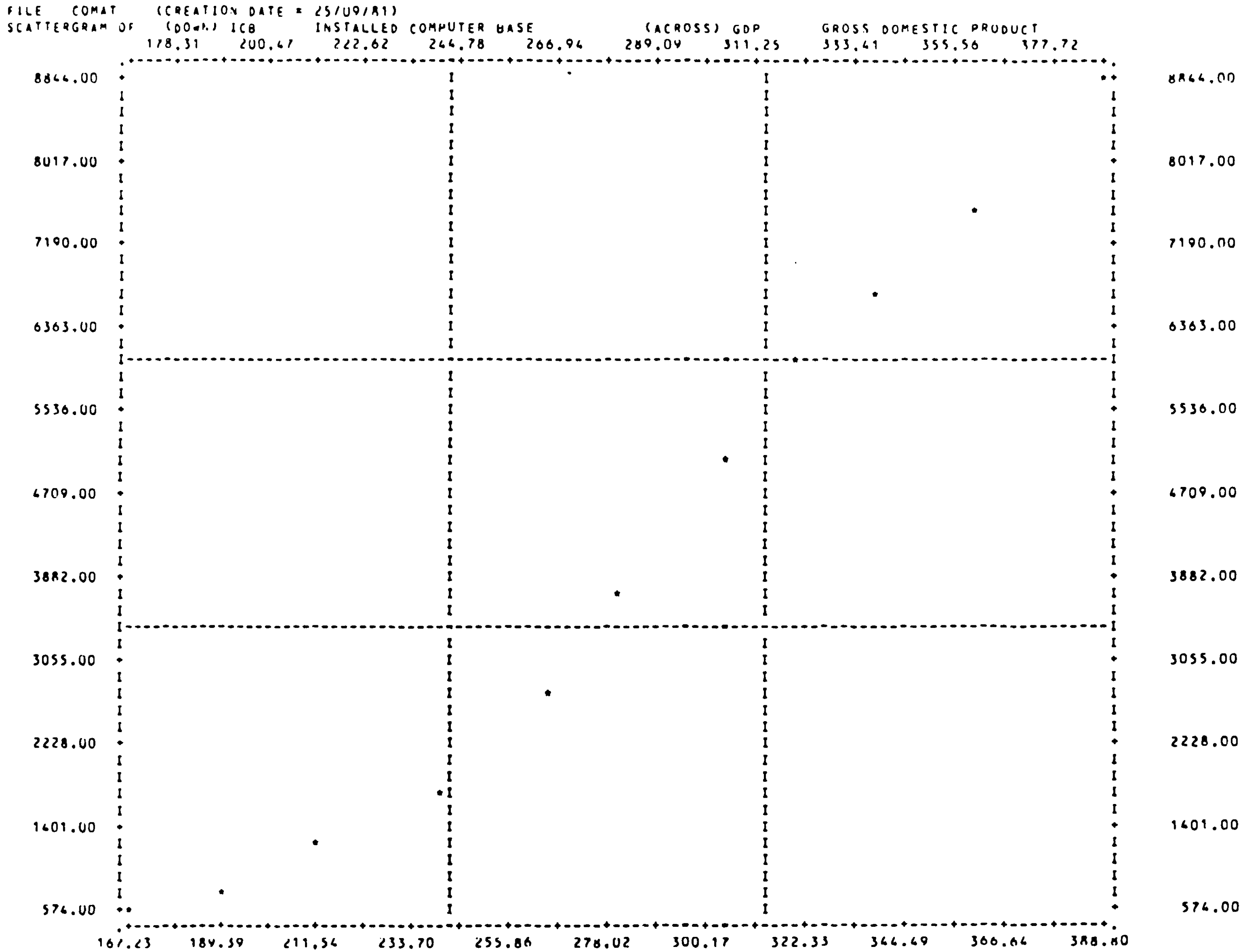


Figure 5.5 Scattergram of Brazil's G.D.P. with the Installed Computer Base, 1970-1980.

5.8. Figure 5.5 shows a scattergram of the data points and the coordinates of the variables considered.

An examination of table 5.8 and figure 5.4 indicates a strong, significant, positive relationship between Brazil's installed computer base and its Gross Domestic Product in the period 1970-1980. ($r = 0.98$; $p < 0.001$). Thus, these results support the United Nations' contention that the total number of computer systems installed in a country is related to its Gross Domestic Product.

5.3.3 GOVERNMENT INTERVENTION

In the last two decades, the historical experience of Japan, France, Germany and The United Kingdom shows us that some degree of government intervention has been developed in the computer market. In general their initiatives could be designated as attempts to protect the survival of indigenous enterprises in the highly competitive markets of the computer industry. (Lee, 1971; The Economist, 1971; Baranson, 1979; Dawson, 1975).

According to the U.S. Department of Commerce (1973) the Japanese Government has been intimately involved in the development of the local computer industry. Since 1958 the Japanese Government developed a network of measures intended to protect the incipient computer industry. Only in the early seventies, when the Japanese manufacturers were relatively consolidated, these measures were alleviated. The British Government also played an important role in providing financial support for Ferranti and ICL, stimulating research and development programmes and fostering the consolidation of small companies in the industry (Management Today, 1980). In 1966, the National Computing Centre was created by the British Government and industry for "promoting an increased and more effective use of computers in every field of national and commercial activity". (NCC, 1981). In the late seventies the British Government has intensified its support for the development of computer technology, particularly in relation to the application of microprocessors. (Economic Progress Report, 1979). In the sixties, the German State stimulated the transfer of computer manufacturing technologies to local firms by establishing an adequate regulatory framework for licensing agreements with American manufacturers. In addition, the German Government supported Siemens and Nixdorf by subsidies, preference in Governmental purchases, and policies to promote the growth of electronics and automation activities in that country. Following the acquisition, by General Electric, of 'Compagnie des Machnines Bull', the French Government established the 'CALCUL' plan, in 1967, in an attempt to reorganize the electronics industry and create a computer manufacturing capability in the country. Recently, the French Government announced measures intended to increase financial support for research and development in microelectronics. (White, 1982). Thus, as Pantages has suggested,

> "Governments and commissions of major industrialized nations and even many

developing nations are trying to ensure that their homelands will have a strong foundation in computer technology, if not lucrative pieces of their own and foreign markets. They are encouraging those partnerships, providing subsidies and intensifying "buy national" pressure - Germany, France, U.K., Japan". (Pantages, 1976:56).

Traditionally, the Brazilian Government has been playing an important role in the economy. Between the thirties and fifties, the State attempted to rehabilitate the economy from the recession, stimulated import-substitution projects in infrastructure, capital goods, chemicals, metallurgy, heavy-industries, etc. In the sixties and seventies the Government has intensified its involvement in steel, chemicals, energy, communications, public utilities, and more recently in electronics, computers, telecommunications, and other technologically dynamic sectors. In general, the participation of the State in the economy has been enormous. The State has been considered not only the main regulator of economic activity but one of the major financers and producers. (The Banker, 1979).

As it may be seen in Table 5.9 the value of computers and related equipment being imported into the

TABLE 5.9

IMPORTS OF COMPUTERS AND RELATED EQUIPMENT, BRAZIL 1970-1980

(In US$ millions)

YEAR	IMPORTS (US$ millions)	INDEX 1970 = 100
1970	27.1	100
1971	46.4	171.2
1972	56.9	209.9
1973	78.5	289.6
1974	98.8	364.5
1975	112.0	413.2
1976	118.0	435.4
1977	100.0*	369.0
1978	130.0*	479.7
1979	150.0*	553.5
1980	180.0*	664.2

Sources: 1970-1976 CAPRE
1977-1980 (Dados e Ideias, 1980)

* Limits fixed by the Economic Development Council (CDE)

country grew considerably from 1970 onwards, forcing Brazil to spend large amounts of foreign currency and increase its Balance of Payments difficulties. In 1971 and 1972 the total amount spent on imported computer equipment corresponded to 13.6 and 23.3% of the Balance of Trade Deficits for those years respectively.

In April 1972, in view of the rising imports of computers and related equipment, national policies and an increasing concern with the strategic and economic importance of computer technology for the country's development process, the Brazilian Government created the Commission for Co-ordination of Electronic Data Processing Activities, (CAPRE) subordinated to the Ministry of Planning. CAPRE's main objectives were to develop an account of the country's resources in computer technology, to design measures in order to maximize the installed computer capacity, to advise the Government on imports of computer equipment for the public sector, and to propose measures for the financing of computer equipment. Initially, CAPRE formulated a resolution requiring that Government Organisations obtained prior approval for the acquisition of computers and equipment valued at more than US$ 225,000. Every request for new computer equipment had to be screened by CAPRE, according to the suitability of the equipment for the proposed application, the technical and managerial level of the human resources available, the services provided by the supplier, and the terms of the contract between the user and the supplier.

In subsequent years, in order to deal with the rising balance of trade deficits, and the massive foreign debt, and in an attempt to optimize the existing installed capacity, the Brazilian Government designed further import restrictions for the computer sector. CAPRE, the National Foreign Trade Council (CONCEX), The Central Bank of Brazil, The Economic Development Council (CDE) and the National Institute of Industrial Property (INPI) established a network of policies and regulatory mechanisms of a relatively complex nature. In December 1975, the National Foreign Trade Council resolution No. 104 established that all imports of computer systems, parts, components and related equipment, were subject to CAPRE'S prior approval. In 1975, the Central Bank of Brazil resolutions 331 and 335 imposed a compulsory deposit of 100% of the FOB value of imports.

The normative act No. 15 from the National Institute of Industrial Property consolidated in 1975, the legislation on technology transfer transactions and redefined the Government's policy for the transfer of industrial technologies. As from 1977, the Economic

Development Council fixed limits on the value of computer and related equipment imports (Resolutions CDE 06/77 and 01/78). In general, these measures, established a virtual ban on imports of computer equipment, parts and components.

In February 1977, Resolution 05/77 from the Economic Development Council established the basic criteria for approving the concession of fiscal incentives for manufacturers of data processing equipment. (Brazil, Economic Development Council, 1977). These were: the index of nationalization of products and components; export potential; technology transfer potential; market competitiveness, and the existence of national capital in the recipient enterprise.

In April 1977, the Industrial Development Council, which orients the Government's industrial strategy, emphasized the need for protecting some sectors of the economy for indigenous manufacturers. As a result of these guidelines, CAPRE adopted a national policy of reserving the minicomputer segment of the market for domestic manufacturers.

In June 1977, CAPRE decided to invite three more companies to manufacture minicomputers in Brazil. Resolution CAPRE 01/77 asked companies worldwide to submit plans to manufacture minicomputers in Brazil.

The criteria for selection were based on the Economic Development Council's rules for granting fiscal incentives. In December 1977, CAPRE selected three local firms, out of sixteen competitors to participate in the minicomputer segment of the market. The firms selected envisaged the acquisition of technology from Nixdorf (Labo); Logabax (SID) and Fujitsu (Edisa). In 1978, SISCO, a company formed by the largest engineering firm in Brazil was given permission to penetrate the market, producing a minicomputer with total compatibility with Data General's Nova 3 model.

6. THE CREATION OF COBRA

6. THE CREATION OF COBRA

6.1. INTRODUCTION

This chapter aims to describe the development of events in Brazil, between 1965 and 1974, leading to the creation of Computadores Brasileiros SA., (COBRA) the pilot company designed by the State in an effort to transfer computer manufacturing technology to Brazil.

We will attempt to take a chronological approach during the discussion.

6.2 THE NAVY'S PLANS

In 1965 the Brazilian Navy was developing an extensive programme of modernization and expansion of its fleet. This programme included the acquisition of modern weapons, vessels, submarine equipment, frigates and measures to promote the incipient electronics industry. According to Uchoa, (1979) their objectives envisaged:

a) An intensive support for the national industry through the development of prototypes of military electronic equipment.

b) The development of national digital technology so as to guarantee the maintenance and future development of their equipment and systems.

c) The acquisition of frigates and military equipment such as computer- based Action Information Systems, weapon controls, etc.

d) The promotion of research and development activities in the Navy.

In general, the projects were aimed at promoting the manufacture of prototype equipment for ships for future production by the Brazilian industry so as to reduce the country's dependence on foreign naval equipment. Initially they would concentrate their efforts on small electronic projects and then proceed to the development of more complex activities. During the execution of these projects they would develop a team of high level personnel capable of receiving and absorbing the most recent technologies in electronics and in naval fields. Presumably, this would help them to create a structure in terms of research and development capable of fulfilling their military ends, and at the same time providing assistance for the expansion of the national electronics and associated industries.

Despite the Navy's limited experience in the field of digital electronics it was thought, at that time, that it would be viable to absorb computer hardware technology by assembling the electronic computers to be installed in the frigates and submarines. The technical and industrial knowledge gained from assembling military computers and systems would provide the Brazilian Navy, private enterprises and research institutions with technological capability for the development of a prototype of an indigenous civil computer with modified characteristics. In co-operation with civilian industry and universities the Navy would transfer to private enterprise the prototype and all technical information that would become available. This would encourage the establishment of an indigenous computer industry in the country.

Basically, these assumptions constituted the starting point of a succession of events and policies, in an attempt to acquire computer technology and develop an indigenous computer manufacturing capability.

6.3 THE SUPPLIER'S INVOLVEMENT IN BRAZIL

According to a Ferranti manager, they first became involved in Brazil in 1967, when a group of Ferranti employees joined a Royal Naval delegation to Brazil in order to make a presentation of naval defence equipment for the Brazilian Navy. At that time the Brazilian Navy was considering the acquisition of frigates as part of the modernization and expansion of its fleet. In an attempt to open up a potentially large market for military and civil equipment, their initial contacts in Rio de Janeiro concentrated on rousing the Brazilian Navy's interest in the possibility of fitting computer-based Action Information and Fire Control Systems in the frigates.

The Brazilian Navy wanted the frigates to be designed to meet their own requirements and specifications. They were also planning to develop research and development capability in shipbuilding, aimed at promoting the manufacture of prototype equipment for ships for subsequent construction by Brazilian industry.

Ferranti had considerable experience with overseas Navies as weapon systems engineers and consultants for major British shipbuilders. Their reputation and technical excellence as manufacturers of defence equipment seemed to be well established world wide. (Management Today, 1980). They had operated in the military and civilian computer markets since 1948 and had become a major supplier of naval technology to the U.K. Government. One of their major contributions to the U.K. naval defence technology was the application of digital computer technology to tactical data handling and weapon control on board of modern warships (Ferranti, 1979).

In the early sixties Ferranti was in the forefront of naval defence technology in Europe. Combining the expertise of its computer and electronics divisions, they introduced the F1600 series of military computers with a wide range of options and peripheral units. This serie was designed to control guns, torpedoes, missiles and a variety of anti-submarine weapons. Perhaps, one example of Ferranti's technical expertise in naval defence technology in the sixties was the Royal Navy's dependence on Ferranti hardware and software technologies for weapon systems. A Ferranti report suggests that:

> "With the introduction of the F1600 series of computers there was a fundamental change in the procedure for programming Royal Naval Systems because from this point onwards, the complete programming of Naval Systems was undertaken by Ferranti" (Ferranti, 1979).

Between 1967 and 1969, in the process of definition of the Navy's requirements for computer equipment and weapon control systems, Ferranti became aware of two major conditions for bidding, through a series of visits, discussions and documents. These conditions were:

a)The supplier of defence technology should co-operate with local industry to provide long term support in a way that would benefit Brazil from the Transfer of Technology.

b) The supplier should operate through a local firm in order to facilitate support and maintenance activities in Brazil.

According to a Ferranti executive they soon recognized the need to operate through a local firm. This could provide the necessary support and maintenance activities and possibly establish a channel for handling future expansion of the civil side of the computer market. However, since they had no previous links in Brazil this meant finding a local partner already established in the business or in a related field.

In April 1970, following previous discussions with the Navy and prospective partners, Ferranti attempted an agreement with Microlab. This was a small privately owned electronics firm operating in Rio de Janeiro with considerable experience in physics and nuclear technology. Despite Microlab's lack of experience in computer technology, it was agreed that they would establish a joint ownership company to undertake contracts with the Brazilian Navy, and, gradually, transfer the required capabilities and elements of technical knowledge.

Since the Brazilian Navy was considering the acquisition of British frigates, in which Ferranti equipment would be incorporated, in the event of a successful bid, this local company would provide the following services.

a) Routine servicing and "on-call" maintenance and repair of Ferranti equipment.

b) Installation, setting-to-work, and preparation for acceptance trials of Ferranti equipment in such ships as are constructed or refitted in Brazil.

c) Preparation of technical documentation in Portuguese.

d) Training of Brazilian Navy personnel in the operation and maintenance of the equipment.

Despite extensive contacts and tentative agreements with Microlab, the joint ownership company was not formed. As a Ferranti manager put it, "Unhappily, Microlab was tempted away from us by Litton, one of our competitors, for the navy's business". Litton and Univac, two major manufacturers of military equipment, were Ferranti's most agressive American competitors. Apparently, Litton was the most likely to be selected by the Navy since they had already established links with Microlab, in order to comply with the local involvement requirement.

In August, 1970, Ferranti approached another electronics firm, appointed by the Navy, Equipamentos Electronics a small Rio-based electronics firm which had some experience in communications and engineering, but no knowledge of digital computer technology. Nevertheless, the Navy approved the contact with Equipamentos Eletronicos and as a Ferranti manager stated, they "moved more quickly into signing an exclusive agreement".

6.4 THE NATIONAL ECONOMIC DEVELOPMENT BANK

During 1968 and 1969 the Ministry of the Navy was still considering the development of a civil computer prototype based on the experience acquired from their military projects. However, in order to develop this project they needed financial support from the National Economic Development Bank (BNDE).

The BNDE is an institution created by the Brazilian Government in the early 1950's to impel the country's economic development process, strengthen the national enterprise, minimize regional differences, further the export growth and to promote the technological development.

In 1964 the BNDE created the Fund for Scientific and Technological Development (FUNTEC) for providing financial support for projects involving basic research, graduate training and the development of technology. According to Teixeira (1980), since the mid-sixties, the BNDE's FUNTEC has been playing a vital role in speeding up the technological development of the country, strengthening the national enterprise, and up-grading human resources.

Within this context, in 1968 BNDE realized the importance of computer technology as a strategic element for the country's development process. (BNDE, 1973). Following contacts with the Ministry of the Navy, BNDE analyzed a feasibility study of a digital real time computer to be developed in co-operation with the Navy, private enterprise and two Universities. In general the BNDE concluded that, at that particular stage of development, it was important, to acquire computer technology for national security reasons and for strengthening the technological structure of the country.

6.5 THE SUPPLIER OF FRIGATES

In September 1970 the Brazilian Navy selected the British Vosper Thornycroft MK.X frigate design for the expansion of its fleet. The Brazilian Ministry of the Navy signed a contract with Vosper in the approximate amount of one hundred million pounds for the construction of six frigates. (Moore, 1977) Four of these were to be built in the U.K. and two in Brazil.

According to Ferranti executives, since they acted, on behalf of the shipbuilders as weapon systems engineers and consultants, the choice by the Brazilian Navy, of Vosper technology meant the installation of Ferranti computer-based weapon control systems and related equipment In addition, the decision in favour of Vosper Frigates seems to have enlarged Ferranti's future possibilities in the Brazilian computer market. At that time, the Navy was not only fully responsible for governmental policies concerning the transfer of computer technology, but also the driving force behind the whole idea.

From the Navy's point of view, the most important criterion considered in the process of selection of frigates was the supplier's willingness to release technology for the recipients. (BNDE, 1973). Considering the strategic importance of defence technology, (Sherman, 1981) there was a preoccupation with an effective transference of naval and computer technology for the Brazilian Navy. It was assumed that the construction of two frigates in Brazil would provide an opportunity to learn by doing. This is considered as one of the best forms for national skill formation. (Balasubramanyan, 1973; United Nations, 1973).

Regarding the relatively high price of the frigates in the context of the Brazilian economic conjuncture of 1970, price does not seem to have been the major buying factor in the process of selection of a technology supplier As one article about the Navy's participation in the computer industry has suggested,

> "In military projects prices are always subject to national security considerations. Sometimes this means the expenditure of large amounts of resources, but, at the same time, this allows us to be in the technological

vanguard, and, in a second stage, benefits the industry of the country". (Jornal do Brasil, 1973:1).

6.6 THE SPECIAL WORK GROUP

In February 1971, the Brazilian Government created a Special Work Group for co-ordinating the design and development of a computer prototype for the Navy. (BNDE,1977)

In order to start its activities in March 1971, the Special Work Group signed contracts with the BNDE and the Ministry of Planning. The financial resources were provided by the Fund for Scientific and Technological Development (FUNTEC 111) of the BNDE, and the Ministry of Planning. Through these contracts, approximately cr$ 10 million were allocated for The Special Work Group.

As a result of the Special Work Group's activities, Ferranti was requested to provide technical assistance and the preparation of an 'integrated plan' for the development of an indigenous manufacturing activity in Brazil. In May 1971, Ferranti and Equipamentos Eletronicos submitted a proposal to the Ministry of the Navy entitled "Integrated Plan for the Design of the National Computer and for Local Support of Naval Digital Systems". This plan included a proposal for the installation and maintenance of naval systems and a plan for the manufacture, under licence of the FM1600-B computer in Brazil.

However, according to a Ferranti manager, the question of FM1600-B technology for civil applications promoted a split of opinion among the participants of the Special Work Group. In general, the 'Navy' group favoured, and the 'BNDE' group opposed it. The main argument was on the appropriateness of the FM1600 technology for civil market applications.

Originally, the FM1600 technology was developed for controlling guns, missiles, anti-submarine weapons, etc. Their main applications were intended to be in Weapon Systems Automation (WSA) (Ferranti, 1979). The FM1600 computers were designed to meet military specifications in respect of ability to withstand shock, vibrations, changes in temperature, while not radiating information which might be picked up by the enemy, etc. Normally, the use of computers in organizations does not require these specifications. With the exception of process control installations, civilian applications usually do not require computer hardware to be used under severe conditions of climate and handling.

In March 1972, the Special Work Group

selected Equipamentos Eletronicos as the domestic partner of the tripartite joint venture. Apparently, this firm was selected for the level of technical capability of its members and for having some experience in absorbing technology from a foreign manufacturer of teleprinting machines. Initially, it was also agreed that the Special Work Group and Equipamentos Eletronicos would together, select the technology-supplier for the joint-venture. A Ferranti manager explained: "This decision naturally favoured Ferranti because of the good relationship we had by then established with Equipamentos Eletronicos".

In July 1972, the Special Work Group determined their strategic guidelines. Two simultaneous objectives would be pursued, in an attempt to establish a national computer manufacturing capability in the country. (BNDE, 1973). These were:

a) Project 1 would aim at the manufacture of an indigenously designed minicomputer.

b) Project 2 would aim at the transfer of computer technology for the manufacture of a foreign minicomputer.

For project 1, resources would be allocated for the design, development and manufacture of a domestic minicomputer aimed at the national market. This became known as the 'Guaranis' project. The prototype would be designed and developed by the Digital Systems Laboratory of the University of Sao Paulo. This University was involved in the design and development of the first experimental Brazilian computer known as "The Ugly Duckling". The Catholic University of Rio de Janeiro (PUC) was participating in the development of software for this project. The prototype developed by these two universities would be manufactured by Equipamentos Eletronicos, the firm through which Ferranti was providing local support, maintenance and services for the Brazilian Navy.

For project 2, resources would be allocated for the transference of computer manufacturing technology to Brazil. According to the Basic Plan for Scientific and Technological Development, this would be achieved through the formation of a pilot company comprising the State, Equipamentos Eletronicos and a foreign firm supplying the required technological resources for the venture. (Brazil, Presidency of the Republic, 1973).

6.7 THE SELECTION OF THE TECHNOLOGY SUPPLIER

In view of the strategic importance of computers and their expected role in the national development process, in 1972 the Special Work Group requested computer manufacturers world wide to submit proposals for the establishment of a pilot company in the computer industry. As they expected, manufacturers from Europe, North America and Japan presented their proposals, in an attempt to penetrate, under favourable conditions, the potentially large Brazilian computer market.

THE FIRST SCREENING PROCESS

However, before reaching a decision, selecting a particular supplier of technology, members of the Special Work Group visited computer manufacturers in the U.K., France, Germany, Japan and the U.S.A. Their mission was not only to establish personal contacts with manufacturers but to discuss licensing terms and whether suppliers would be willing to participate in a joint venture designed for the enterprise. According to Uchoa (1979), the main criteria applied by the Special Work Group in selecting the technology-supplier for the joint-venture were the following:

a) The supplier of technology would not impose any export restrictions or territorial limitations of any kind. (Since 1964 the Brazilian law prevented export restrictions to be included in licensing contracts).

b) The technology-supplying organization would agree to transmit the required elements of technical knowledge without restrictions, and to provide information on technology improvements.

c) The supplier of technology would not prevent the recipient from acquiring technology from other sources.

d) There would be established a time limit within which the recipient would be allowed to sub-license technology to third parties.

According to a Ferranti executive, after these criteria were established,

"A long drawn out struggle developed with eight foreign companies trying to win the favour of the Special Work Group. Various ground rules for selection were laid down,

> changed and changed again. The Ferranti bid was strengthened by the introduction of a proposal to manufacture Argus 700 in Brazil. This gave Ferranti at once a technical edge over the others and got round the limitation of the restricted field of application of the FM1600 range".

At that time, the Argus 700 was Ferranti's latest computer design for civil applications. Argus 700 was just coming into the British and European markets as a general-purpose, real-time minicomputer which could be utilized for business data processing, data communications, process control applications, freestanding computation in universities and research laboratories, etc. According to an independent technical report on the Argus 700 series system,

> "When Ferranti originally announced the Argus 700 series in June 1973, the series was ahead of its minicomputer competitors in several respects. It was one of the first to offer high-level languages for real-time programming, and certainly the first to have an instruction set expressly designed for efficient compilation of high-level source languages". (Auerback, 1979).

In the first screening process, the Special Work Group analyzed eight companies and came to the following conclusions:

a) AEG-TELEFUNKEN, PHILLIPS These companies were not interested in the general terms of technology transfer proposed for the venture.

b) HEWLLET-PACKARD was not willing to participate in a minority position.

c) DIGITAL EQUIPMENT did not agree to license technology without export restrictions.

d) VARIAN, CII, FUJITSU, FERRANTI. These companies were still interested in terms of licensing and form of participation.

THE SECOND SCREENING PROCESS

Since the special Work Group and Equipamentos Eletronicos had to select only one supplier of technology, they decided to adopt a second screening process, consisting of the following items:

a) The terms and conditions under which technology would be transmitted.

b) A technical comparative analysis of the various products in terms of hardware and software.

c) The supplier's capability in terms of research, development and innovations.

d) The supplier's position in terms of the scale of integration and semiconductor technology utilized.

e) The supplier's range of peripherals, data entry, communication and special equipment (Uchoa, 1979).

As a result of second screening process, and additional contacts established with VARIAN, FERRANTI, FUJITSU and CII, the Special Work Group narrowed the field to Ferranti and Fujitsu.

Ferranti was proposing the Argus 700 series of computers, which could be used for both military and civil applications. (Management Today, 1980) Fujitsu, one of the largest manufacturer of computers, components and telecommunications equipment in JAPAN, was proposing the PANAFACOM V-200 mini computer system. Fujitsu had been supplying computers to the Brazilian market since 1970 and was also co-operating with SPAIN in the development of a computer industry. Their product was specifically designed for commercial applications. (Fujitsu, 1978).

Equipamentos Eletronicos appointed Ferranti for the venture. However, the Special Work Group faced another split of opinions and interests. The Ministry of Planning and BNDE's representative selected Fujitsu's Panafacom V-200. The Navy's representative opted for the Argus - 700.

According to a Ferranti manager's view of the second screening process,

> "They were not simply comparing the technologies of different contenders. They were comparing the whole package deal the different suppliers were offering".
>
> "The Special Work Group looked for technical advice outside ... I think that the most influential people from a technical point of view were individuals from the Catholic University of Rio de Janeiro".
>
> "But really, most of the arguments were political ..."
>
> "Within the Special Work Group Mr. A wanted to go Fujitsu and Mr. B wanted to go the Ferranti way, and the final decision was that

they would go both ways".

In April 1973 the Ministry of Planning reached a compromise between the BNDE and Navy's interests. It established a Government holding company with a military and civil division to accommodate the divergent interests. The holding company, Brazilian Digital Electronics (EDB), was controlled by the BNDE (63%); CEF - a State Bank (10%); SERPRO- The Federal Service for Data Processing (10%); TELEBRAS, the State Telecommunications enterprise (10%); and others (7%). The EDB's initial capital was Cr $ 100 million. (BNDE, 1973). Thus according to national policies, EDB would be the state partner in the tripartite joint-venture designed to transfer computer manufacturing technology to the country. (Brazil, Presidency of the Republic, 1971, 1973). In an attempt to transfer both civil and military computer technology, EDB would establish two subsidiaries, as follows.

a) Company A - This company would be formed between EDB Equipamentos Eletronicos and Ferranti. It would be concerned primarily, but not exclusively, with the manufacture of military computers.

b) Company B - This company would be formed between EDB, Equipamentos Eletronicos and Fujitsu. It would be concerned with the manufacture of computers for civil applications. (BNDE, 1973).

In 1974, the Brazilian economy began to reflect some problems associated with the world petroleum crisis. Among other things, there was a sharp decline in the Gross Domestic Product and the real output growth rate of the industrial product, an unprecedented deficit in the balance of trade, a large deficit in the balance of payments, and a return to the relatively high inflation rates of the previous decade. In view of Brazil's conjunctural economic problems and the strategic importance of company A in relation to current naval projects, among other things, the creation of this company was given priority over company B.

6.8 COMPUTADORES E SISTEMAS BRASILEIROS (COBRA)

In May 1973, EDB signed an agreement with Equipamentos Eletronicos, Ferranti and representatives of the Special Work Group envisaging the creation of company A. This company would be registered as a limited liability partnership, with initial capital subscribed in equal parts by the three partners. Their objectives would be:

a) The provision of support to the Brazilian Navy, in terms of installation maintenance, repair and training.

b) The provision of support activities to the Brazilian Navy for equipment supplied by other manufacturers.

c) The development, manufacture, sale and support of digital systems for the Armed Forces of Brazil and for export.

d) The development, manufacture, sale and support, in Brazil and for export, of digital systems in non-military fields.

Following recommendations by the Special Work Group, on July 25, 1974, Computadores e Sistemas Brasileiros Limitada (COBRA) was formed, as a limited liability company, between Eletronica Digital Brasileira (EDB), Equipamentos Eletronicos (EE) and Ferranti. According to Brazilian legislation, the limited liability company was characterized by the fact that the liability of the partners was limited to the amount of subscribed capital. Thus if the partnership were to become insolvent the partners were not affected by the debts of the company, beyond the subscribed capital.

Cobra's initial capital was Cr$ 1.2 million, subscribed in equal parts by the State, Equipamentos Eletronicos and Ferranti. The control of COBRA would be exercised by a three man council representing each shareholder. Management would be exercised by three directors, nominated by the partners. The industrial director would be appointed by Ferranti, while the Financial and Commercial directors would be nominated by EDB and the local partner, respectively.

According to National Development Plans, Cobra was expected to play a pivotal role in the transference of computer manufacturing technology to the country. (Brazil, Presidency of the Republic, 1971, 1974).

The following chapters are concerned with the process of transferring technological resources from the technology-supplying to the recipient organization. Chapter 7 presents the terms and conditions under which computer technology was transmitted to Cobra. Chapter 8 discusses four hypotheses related to the supplier and recipient's perceptions of the transfer process.

7. THE TECHNOLOGY TRANSFER PROCESS

7. THE TECHNOLOGY TRANSFER PROCESS

7.1 INTRODUCTION

The major aim of this chapter is to analyze some aspects of the contractual arrangement between Cobra and Ferranti and the mechanisms utilized for the transference of technological resources. It includes an overview of the contractual agreement between the transferor and transferee, the forms of technology involved in the transaction, trademarks, information on technogical improvements, the training of human resources, the provision of technical assistance, the payment of royalties, and the settlement of disputes.

7.2 THE CONTRACTUAL TRANSFER OF TECHNOLOGY

Within the framework of the Brazilian legislation and policies on technology transfer discussed in section 4.4, some aspects of the contractual agreement between the transferor and transferee will be examined. Appendix 1 presents the original technology transfer contract (1.1) between

Cobra and Ferranti before the INPI's consolidated legislation and an amendment to the agreement, made after the specific legislation on technology transfer (1.2).

Following the formation of COBRA as a limited liability company on July 18, 1974, an Agreement of Technical Information, Assistance and Training was made between COBRA and Ferranti. This agreement was registered at the National Institute of Industrial Property on August 8, 1974, and endorsed by the Central Bank of Brazil on the 19 August, 1974.

Later, in view of Cobra's new requirements regarding hardware and software modules, an Agreement of Technical-Industrial Co-operation was appended to the initial contract on June 23, 1976. This amendment was made according to the INPI's consolidated regulatory framework.

7.2.1 THE TRANSFER AGREEMENT

The technological transactions involved a mix of patented and unpatented technologies in the form of capital and intermediary goods, human skills and information. The agreement designed to transfer this mix of technologies, however, was denominated

'Agreement of Technical Information, Assistance and Training'. Although the contract could have been denominated a licensing agreement it was not characterized as such. A reasonable explanation for this different denomination seems to be related with INPI's strict attitude in its approval of technology transactions which involve additional burdens to the balance of payments. (Wallender, 1979:190). One Ferranti manager who participated in the negotiation of the technology transfer contract with the INPI provided some comments on the difficulties associated with getting the INPI's approval of the contractual arrangement between Ferranti and Cobra:

> "The problems we had to deal with INPI gave us a very good impression that technology was the last thing on earth they wanted".
>
> "They were very bureaucratic and appeared not to take any notice of everybody else in Brazil".
>
> "Basic rule number one seemed to be no money should be paid for an exchange for know-how, and there should not be any royalties ..."
>
> "I think that a lot of malpractices which had been going on ... (evasion of currency

> regulations, disguised payments for know-how and royalties, etc) ... made life very difficult not just for us but for all people who were trying to do genuine straight forward, sensible commercial deals".
>
> "We started with our own idea of what a licensing agreement should be in terms of payments, royalties, etc, but we had to do a compromise in the middle ... "

When the initial agreement was made in July, 1974, the INPI had not defined any specific policy to determine how technology transfer agreements should be measured. As Figueredo (1972) suggested, there was not a coherent legal framework concerning technological transactions in general. What could be found was a collection of laws and regulations generated at different times by isolated institutions with different objectives in mind. In these circumstances, it seems that technological agreements were decided on a case-by-case basis by the INPI. Perhaps, some of the problems associated with negotiating the contract under which various forms of technology would be transferred derived from the fact that there were no specific policies to orient the supplier and recipient of technology, or to estimate the value of the technologies in relation to the current economic priorities.

7.2.2 FORMS OF TECHNOLOGY INVOLVED

The general aim of Agreement of Technical Information, Assistance and Training was "to acquire from Ferranti certain know-how and information" needed for the manufacture and sale of Argus-700 computers in Brazil. Specifically, this involved the acquisition of a mix of manufacturing, product and management technologies, in the following forms, as defined by the United Nations: (1972:5).

a) CAPITAL GOODS. These included peripherals not designed by Ferranti such as line printers, disk storage units, magnetic tape deck, plotters, paper tape punch, paper tape reader, teleprinters, etc. In the contract, special references to these peripheral equipment were made by clauses 2(iii) and 9(ii).

b) INTERMEDIARY GOODS. Refer to the hardware modules, equipment and components related to the manufacture of Argus-700 computers. They include various electronic and electro-mechanical components such as central processor modules, monitor units, store access units, general purpose logic elements, input/output units, printed circuit boards, registers, cooling fans, power supply units, etc. In the contract these hardware modules and other intermediary goods were designated as "The products". (Clause 1(i).

c) HUMAN RESOURCES. These included training of engineering and managerial personnel at the supplier's premises in the United Kingdom (Clause 4) and the support of Ferranti's engineers of COBRA's plant in Brazil. (Clause 5). Details of training activities and Ferranti's support in Brazil are provided in section 7.2.6

d) INFORMATION. This item can be subdivided into two sub-items as follows:

SOFTWARE - Refer to the basic, auxiliary and application software designed to control the internal operations of the computer and the execution of specific tasks. Basically they consist of sets of programmed instructions written in a computer "language" to control the execution of various tasks. In the contract, the basic software needed for the operating system was termed 'standard software package' (Clause 3(i)) while the auxiliary software such as the CORAL and FORTRAN compilers, and other application programs were referred to as 'Other Software Packages'. (Clause 3(ii)).

TECHNICAL DATA PACKAGES - These refer to the documentary information which describes how to assemble the modules, parts, components, materials and the techniques used to carry out the production process. Among these packages there are specifications for materials, photographic processes, design standards, quality assurance testing, layout of production area, etc. The contract refers to these technical data packages as 'Technical Information' (Clause 1(ii)).

7.2.3 DURATION OF THE AGREEMENT

The United Nations Conference on Trade and Development sees the duration of contractual agreements involving transfer of technologies as an important element in the contract between the transfering and recipient enterprises. (United Nations, 1975, 1978) The basic argument is that the contract duration may tie the recipient to outdated technologies. Katz found that, in Argentina, 18 out of 60 contractual agreements researched specified periods between 7 and 10 years, while some were for 50 years or more, (Katz, 1972). In an empirical research focussed on British industry Taylor and Silberston (1973) pointed out that in the electronics sector, where technology was changing rapidly, the five year period of duration for patent and know-how licensing agreements was being increasingly preferred by British companies. They also indicated that there was considerable variation in relation to the duration of the agreements, depending on the nature of the technology involved and the bargaining strengths of the parties.

Although the original contractual agreement between Ferranti and Cobra was signed before the INPI's normative act No. 15 regulating the subject, the term of the contract matched INPI's later requirements. In relation to the duration of the technology agreement, the initial contractual bound established between the partners was five years. The effective date of the agreement, however, was the date Cobra notified Ferranti that the necessary approvals of the Brazilian government authorities were obtained. (Clauses iv and 17).

The INPI approved the agreement on the 8th of August 1974 and the Central Bank of Brazil endorsed the contract on the 19th of the same month.

The supply of "technical information" relating to the hardware modules and other products (Integrated circuit boards, central processor circuits, power supplies, input/output devices, magnetic tape controllers, peripherals, etc) could be requested by Cobra within two years of the effective date of the contract. (Clause 2(ii) In respect to those peripherals, parts or components not designed by Ferranti, (The Calcomp plotter, Card Readers, Line Printers, Magnetic Tape Units, Disk Storage Units, etc) there was no obligation to supply any information related to these products, except the description of the functional requirements of the products and the identification of the original manufacturers (Clause 2(iii)).

As regards the aquisition of software modules, (the set of programs such as the basic, auxiliary and application software, compilers, etc) they could be requested by the recipient at any time within the duration of the agreement.

7.2.4 TRADE MARKS

A trade mark is basically a distinctive mark connected with a product or process. When a licensor grants a trade mark to a licensee, as part of a technology transfer package, it is assumed that there are contractual arrangements assuring maintenance of the traditional standards associated with the product. As Behrman (1976:55) put it, "no licensor is willing to see the quality of its trademarked products differ significantly in several markets around the world".

Under clause 16 of the agreement, the computers built by Cobra should carry the inscription "Manufactured under licence from Ferranti Ltd". This was considered normal under the 1974 legislation concerning license agreements. However, the new INPI's regulatory framework on contracts of technico-industrial co-operation prohibited the explicit use of trade marks connected with licensing agreements. (Provision 5.5.2a of the INPI normative act No. 15, appendix 2) Thus, if a licensee wants to incorporate a trade mark in the technology package, a separate agreement has to be registered at the INPI, according to the provisions established for this category. (Provision 1.1c).

7.2.5 INFORMATION ON TECHNOLOGY IMPROVEMENTS

In the international literature on technology transfer, this concept is usually referred to as "grant-back provision" (United Nations, 1978; Wallender, 1979; Pearlmutter, 1976; Behrman, 1976).

A United Nations study summarized the situation regarding apparent limitations on the access to technology improvements by recipients in developing countries as follows:

> "Technology suppliers also insist that recipients inform them of any improvements made in the technology without, however, any obligation to pass on to recipients information about improvements which they may make themselves. Thus, the licensee is deprived of access to the fruits of the licensor's research and development, to which he nonetheless contributes through royalty and other payments, whereas the licensor can take advantage of any development by the licensee without having made any financial cntribution to it". (United Nations, 1975: 23).

The same study reported that the "non-reciprocity" practice was widespread in Argentina and the Philippines. Another study also published by the United Nations (1978) recognised the difficulties involved in defining what constitutes an improvement in technology and what could be termed new technology. Despite the considerable conceptual problems inherent to drawing a line between improvements vis-a-vis new technology, the study suggested that a practical definition of the required technology should be included in the contractual agreement and recipients should not accept any limitations regarding grant-back provisions.

The agreement for transfer of a computer manufacturing capability between Cobra and Ferranti stipulated a two-way exchange of technology during the period of the contract. Clause 13 states that each party "shall promptly after incorporating any improvements in products manufactured by it inform the other party of such improvement and shall as soon as is reasonably practicable supply to such other party technical information relating to such improvement". However, it was also agreed that the receiving party would be responsible for using the information which could lead to technical improvements as well as for the quality and performance of the resulting products. (Clause 14).

Behrman sees a two-way exchange of technology as probably more valuable to the recipient than exclusive control over future technological developments. From the supplier's point of view he argues that "no licensor will readily give up the use of its technology if it considers the licensee to be in a position to make technological improvements that may preclude the licensor's ability to readily enter the world market. Therefore, grant-backs merely continue the ability of the licensory to stay in the game" (Behrman, 1976:53).

Depending of the objectives of the supplier and recipient, a two-way exchange of technology seems to be, in principle, a reasonable means of participating at each other's research and development efforts. For instance , recently, there have been some equipment developments in Brazil. Cobra produced a combination of hardware and software elements for a local organization of supermarkets, designed for use in stock control within the chain. This application required the use of a special peripheral terminal equipment which was designed specifically for the supermarket chain. Both the hardware and software components of the application were designed , developed and made entirely by Cobra. As the real time stock control system was operating in the supermarket chain, the British Airport Authority was considering installing in each airport some processing equipment with similar characteristics. The application basically involved providing a terminal for each of the different shops at the airports. This data processing equipment in the airports would offer the various shop concessionaries with facilities to do stock control, accounting, payroll, etc.

Ferranti immediately saw the similarity between the British Airport Authority's needs and the Brazilian supermarket chain application. Instead of developing completely new hardware and software to meet the needs of the airports, Ferranti was considering using Cobrá's equipment in England, with some minor modifications in the software to meet the requirements of its clients.

In the international literature on technology transfer this would be considered an example of the "reverse of technology transfer" (OECD, 1975). Perhaps, what is interesting to note is that this presumable flow of technology in the other direction implicitly seemed to carry with it some of the problems usually associated with the aquisition of technology by recipients from developing countries. For instance, one Ferranti manager stated:

> "Those terminals might be ideally suited ..."
> " ... and probably if they do the easiest way

would be to buy some, rather than to get the design, because if we do that and start putting it into our manufacturing then we would have the problems of understanding their drawings, and their ways of doing things, finding their special finite components that are not easily available over here or have to be identified to come from some other suppliers and so on ..."

Some of Cobra's managers and technicians interviewed in Brazil also stressed the difficulties they had in understanding Ferranti's documentation and technical information. One software engineer who participated in the early training programmes in England stated:

"I expected to find a very clear documentation of the software that I was going to use in Brazil. However, what I could find were mostly drafts of ducumentation ...
Suddenly I found myself in a situation that I had to understand the programs and, at the same time, develop a clearer documentation ..."

Perhaps, from the Cobra-Ferranti experience discussed above, the following points appear to be worth noting:

1. Considering the lack of definitions as to what constitutes an improvement in technology as opposed to a new technology, it seems that this could lead to considerable misunderstandings if a dispute were to arise between the technology supplier and recipient. This suggests the need for a mutually agreed definition of terms to be included in technology transfer contracts.

2. Another factor which could, perhaps, lead to misinterpretations is the the expression "as soon as is reasonably practicable" as a time factor in clause 13, establishing the terms under which technological developments would be exchanged between the parties. A less flexible time limit would possibly make this clause clearer.

3. Considering the dynamic nature of technological changes in the electronics sector and particularly in the computer industry, (Taylor and Silberston, 1973;

Withington, 1975; Baranson, 1979; Brock, 1975; Harman, 1971; EIU, 1979a) the inclusion of two-way exchange of technology clauses seems to be a reasonable proposition for both sides of the technology transaction. It may enable both the supplier and recipient to gain from external economies derived from each other's resources invested in research and development activities.

7.2.6 TRAINING OF HUMAN RESOURCES

The notion of training as a mechanism for the transfer of technology appears to be well recognized in the literature. (UNCTAD, 1972; Doctors, 1971; Lynton, 1969).

Training of technical, engineering and managerial personnel at the premises of the technology supplier in England seemed to be considered a crucial element of the envisaged technology transfer process. A Ferranti director was explicit in this point:

> "We were well aware that transfer of technology was not simply sending pieces of paper together with the hardware. We could have sent drawings, service manuals and all that, but that isn't ... It is too complex a subject. We were aware that there had to be a lot of training..."

The Agreement of Technical Information, Assistance and Training (Appendix 1.1) established that fifty personnel of Cobra were to be trained at Ferranti's premises in England. (Clause 4). The length of the training courses were approximately four months for each individual, at times mutually agreed between the technology supplier and recipient. These training activities were to be conducted in the English language, within two years of the effective date of the contractual agreement. This period, however was extended to December 1976, according to clause 1.4 of the Agreement of Technical Industrial Co-operation (Appendix 1.2).

Although the contractual agreement did not detail the chronogram of the training activities or the categories of personnel needed to participate in such training, a tentative training scheme was designed by Ferranti. According to one Ferranti manager, this scheme involved training the following categories of Cobra's personnel:

1. Administration and Planning Managers.

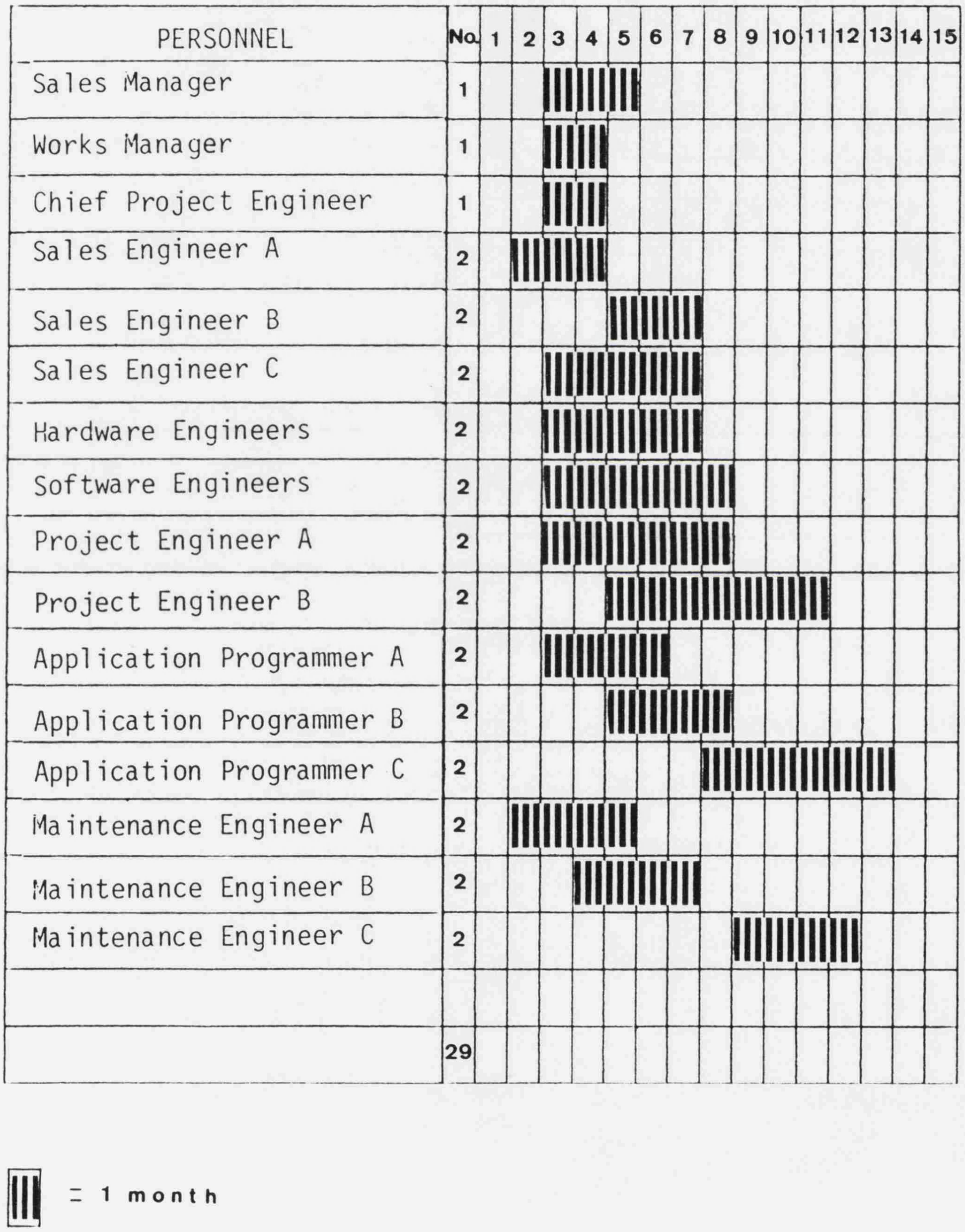
2. Sales and Support Engineers.

3. Hardware and Software Engineers.

3. Maintenance Engineers.

4. Production Engineers.

Figures 7.1 and 7.2 show the chronogram of training activities planned for the various categories of personnel to be developed in England. The training courses comprised a variety of subjects, some specially prepared for the recipient's personnel, and others derived from standard courses prepared for the supplier's own requirements. Some training activities included not only lectures, but periods of supervised practical experience in the factory.



No. = Number of individuals

Figure 7.1 Chronogram of training activities - Part 1.

PERSONNEL	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Production Engineer A	1		█	█	█	█										
Production Engineer B	2				█	█	█	█								
Production Manager	1		█	█	█	█										
Inspection Engineers	2						█	█	█							
Processor Test-Technician A	1			█	█	█	█	█								
Processor Test-Technician B	1						█	█	█	█	█					
Stores Test-Technician A	1			█	█	█	█	█								
Stores Test-Technician B	1						█	█	█	█	█					
Backing Store Test-Tech.	2						█	█	█	█	█					
Input/output Test-Tech. A	1			█	█	█	█									
Input/output Test-Tech. B	1						█	█	█	█	█					
Peripheral Test-Tech.A	1			█	█	█	█									
Peripheral Test-Tech B	1					█	█	█	█							
Display Test-Technician A	1		█	█	█	█										
Display Test-Technician B	1					█	█	█	█							
System Test Engineer A	1						█	█	█	█	█	█				
System Test Engineer B	2						█	█	█	█	█	█	█	█	█	
	21															

█ = 1 month

No. = Number of individuals

Figure 7.2 Chronogram of training activities - Part 2.

7.2.7 TECHNICAL ASSISTANCE

Another aspect of the preparation of Cobra's human resources was the provision of technical assistance by Ferranti's engineers, at the recipient's premises in Brazil. The rationale for the support of the transferor in loco was emphasized by a Ferranti's manager:

> "Once we got the contractual arrangement under which the information would be supplied, then it became possible to go ahead and actually do it ... (the transfer activities)
> Actually, doing it involved a whole string of complications, which I think, that the key element was that in order to transfer complex information from one organization to another you have to have a group of people in the other organization who is able to accept and absorb that information ...
> We believed that it would be necessary for a fairly large team of experts to go to Brazil, stay there alongside the Brazilians in building up the capability".

The general idea, according to another Ferranti manager, was to provide Cobra with engineers and managers who had practical experience in getting things manufactured. They would be based at Cobra's premises in Rio, working closely together with the Brazilians, for a few years. They would also help to select capable, although relatively inexperienced, personnel to become Cobra's managers of the various departments. These managers would actually be in charge of the various departments, but at the beginning they would not be making any decisions. They would be working in conjunction with the English experts. Then, a gradual transfer would be possible, as they gained on-the-job experience. The notion of this on-the-job training as a learning mechanism (Arrow, 1962) and as a technology transfer instrument (Behrman, 1976) has been recognized in the literature.

The importance of technical assistance as a face-to-face medium for transferring technologies and the mobility of technical personnel are emphasized in the literature in a variety of ways. Utterback's (1975) suggested that face-to-face contacts and discussion of alternatives between supplier and recipient personnel were effective channels for transfering technology. Local support abroad was also considered an essential factor in the transfer process.

Doctor's evaluation of the NASA technology transfer program stresses the value of the mobility of the technologist, continuing personal contacts between supplier and recipient personnel as transfer mechanisms. He also considered these mechanisms to be more effective than the traditional programs of transferring technical information. Goulet (1977) also emphasizes the importance of personal interaction, daily contact, working closely together, getting to know each other and developing trust and confidence. Figure 7.3 presents the proposed chronogram of activities involved in the supply of technical assistance at Cobra's premises in Rio and the following categories of human resources provided by the technology supplier:

1. Sales Managers

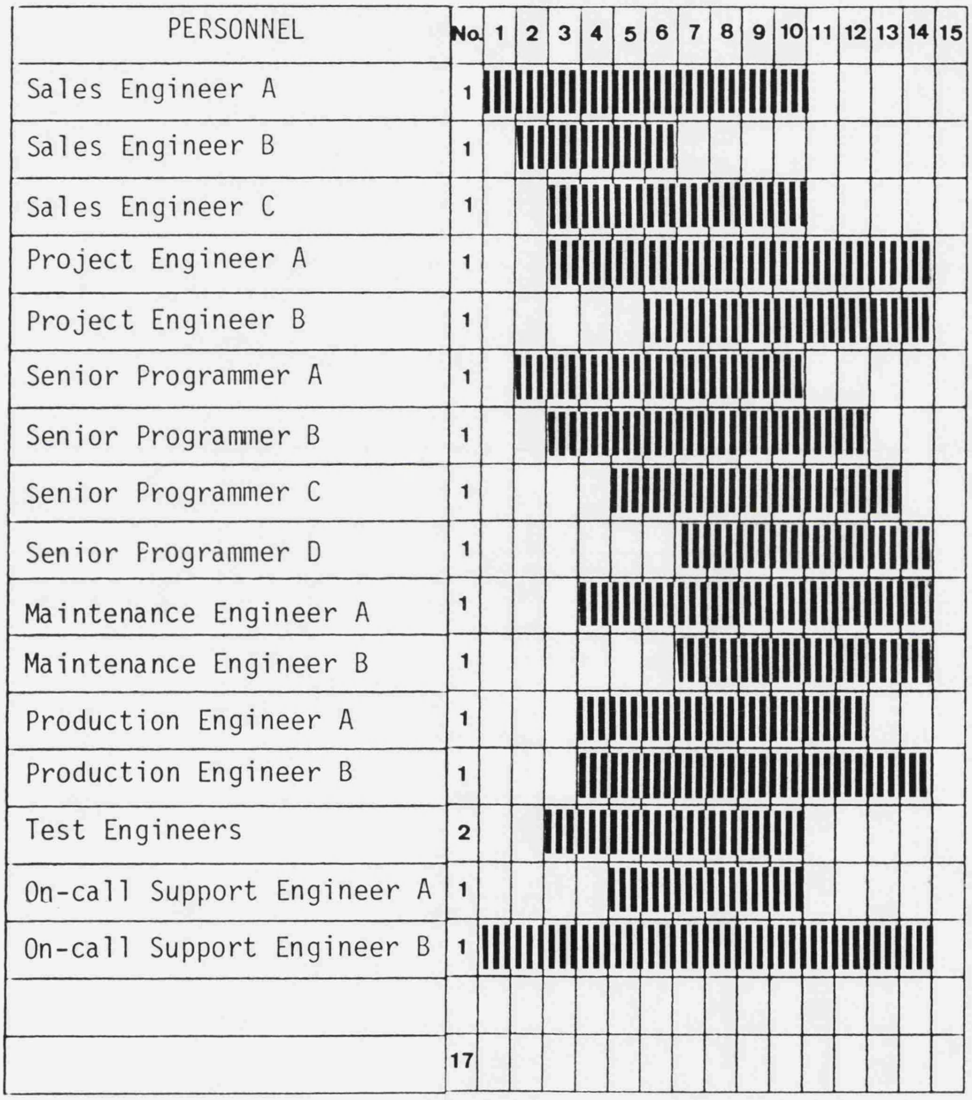
2. Hardware Engineers

3. Software Engineers

4. Maintenance Engineers

5. Production Engineers

6. On-call Technical Consultants



= 3 months

No. = Number of individuals

Figure 7.3 Chronogram of technical assistance.

7.2.8 RATES OF ROYALTY

The question of the rates of royalty involved in international license agreements for the transfer of technology seems to be much discussed in the literature on technology transfer. In a study of the ownership policies of multinational corporations in less industrialized countries Stopford and Wells (1972) suggested that in joint ventures profits may be transferred to the parent companies disguised as royalty payments for technological agreements. Thus, host governments sometimes impose barriers to the transmittal of royalties, just as they do against dividends. (Robins and Stobaugh, 1973).

Taylor and Silberston (1973: 120-124) suggested that although the factors affecting the determination of royalty rates of patent and know-how license agreements are complex and difficult to generalise, the following principles seemed to be relevant:

1 - The volume of physical output. The larger the volume of output the lower the rate of royalty to be applied, ceteris paribus. Thus, the rate of royalty tended to be inversely proportional to the level of

output.

2 - The elasticity of demand. In some markets where the elasticity of demand for the product is "exceptionally" low, as for components which may affect the safety of airplanes, the rate of royalty tended to be relatively higher.

3 - The amount of know-how supplied. The greater the amount of know-how involved, the greater the level of royalty, ceteris paribus.

4 - The value of finished products. In some sectors where components and other inputs are produced under license for the manufacture of a finished product, royalty rates tended to be fixed in relation to the value of the finished product.

In a sample of 27 firms, they found that 14 respondents reported royalty rates between 2.5 and 5 percent. The sample mean was 4.2 per cent. In the chemical and electrical engineering sectors respondents were concentrated around 2.5 - 5 per cent while in the mechanical engineering sector the subjects were in the 5 - 10 per cent range. The relative importance of know-how in the mechanical engineering sector and the nature of the market (limited, specialist markets) were considered to be the probable determinants of the higher rates of royalty in this field.

The rates of royalty agreed between Ferranti and Cobra were determined in accordance to clause 9(vii) of the technology transfer contract (Appendix 1.1). In the agreement, the rate of royalty is referred to as "Applicable percentage levy".

The contractual rate of royalty varied between 2 and 5 per cent of the net selling price of any product or derivative, manufactured, assembled or repaired by Cobra, and was determined according to the following formula and variables:

$$\text{Rate of Royalty} = 5 / (1 + (10 (D / P)))$$

Where:

P = Cobra's Total Annual Net Sales

D = Ferranti's Relative Participation in Cobra's Capital Structure

Figure 7.4 shows the relationship between the rates of royalty, annual sales and Ferranti's various

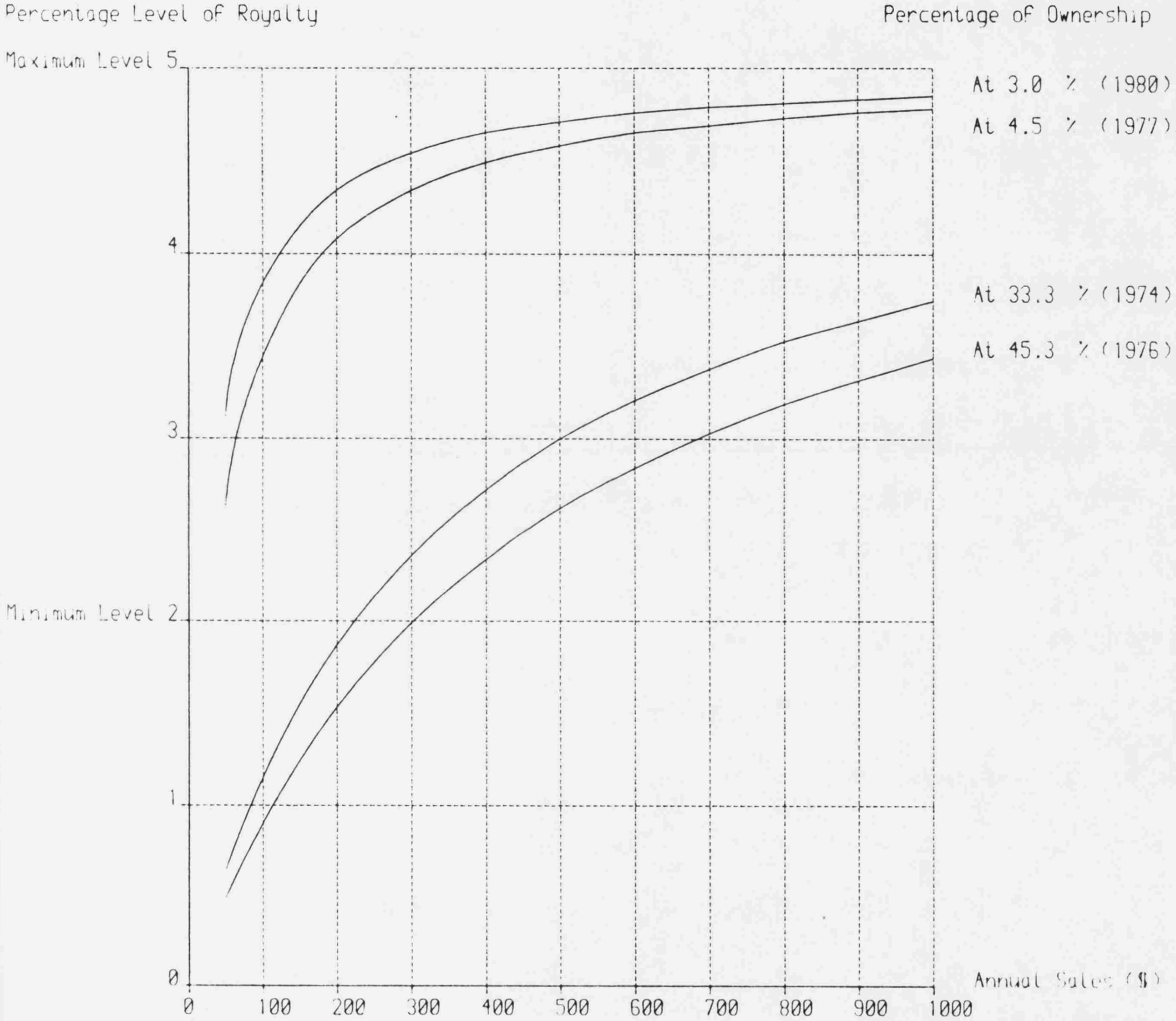


Figure 7.4 The Relationship between Levels of Royalty, Annual Sales, and the Technology Supplier's Relative Participation in the Recipent's Capital Structure

levels of relative participation in the capital structure of Cobra. Table 7.1 contains the calculated rates of royalty associated with Ferranti's relative participation in Cobra in 1974, 1976, 1977, 1980, and the values of simulated sales derived to analyze the relationship between the variables. Figure 7.5 illustrates the relationship between the levels of royalty, simulated sales, and the supplier's relative participation in the recipient's capital structure.

In 1974, when Ferranti owned 33.3 per cent of Cobra's capital structure, if sales had reached 100 monetary units the calculated rate of royalty would have been 0.65 per cent. However, since this value was below the minimum applicable rate, 2 per cent would prevail. In 1976, even considering that Ferranti's participation increased to 45.3 per cent, the 100 sales value would still have generated a royalty rate (0.49) lower than the minimum required level. In 1977 the same sales level would allow a royalty rate above the minimum standard, (2.63) since Ferranti's percentage of ownership of Cobra had decreased to 4.5 per cent that year. In 1980, considering a lower percentage of ownership, (3.0) the same sales level would have produced a higher royalty rate. (3.12).

An analysis of figure 7.4 and Table 7.1 suggests the following points in relation to the relationship between royalty rates, annual sales and the level of the technology supplier's participation in the recipient's ownership structure:

1. At any percentage level of ownership, the greater the amount of sales the greater the royalty rate. Thus, the rates of royalty varied directly proportional to the amount of sales.

2. The lower the level of percentage ownership the greater the rate of royalty, ceteris paribus. In other words, the percentage level of ownership varied inversely proportional to the estimated rates of royalty, if sales were kept constant.

Table 7.1 Calculated Rates of Royalty for various sales values and percentages of ownership

	1974	1976	1977	1980
Sales/% of ownership	33.3	45.3	4.5	3.00
50	0.65	0.49	2.63	3.12
100	1.15	0.90	3.44	3.84
200	1.87	1.53	4.08	4.34
300	2.36	1.99	4.34	4.54
400	2.72	2.34	4.49	4.65
500	3.00	2.62	4.58	4.71
600	3.21	2.84	4.65	4.76
700	3.38	3.03	4.69	4.79
800	3.53	3.19	4.73	4.81
900	3.64	3.32	4.76	4.83
1000	3.75	3.44	4.78	4.85

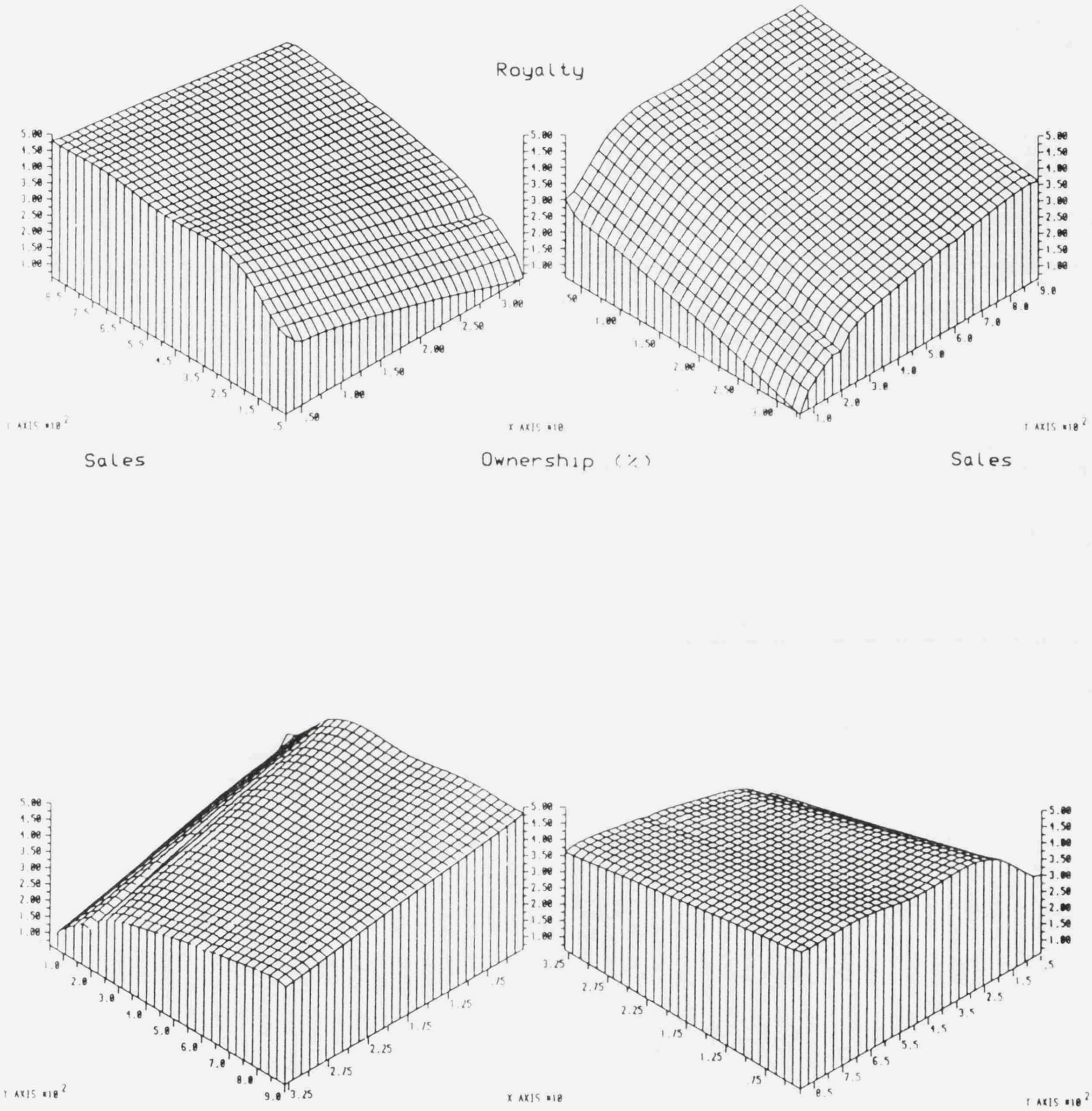


Figure 7.5 Isometric Projection of the Relationship between levels of Royalty, Annual Sales, and the Technology Supplier's Relative Participation in the Recipient's Capital Structure.

7.2.9 THE SETTLEMENT OF DISPUTES

According to clause 27 of the contractual agreement, any disputes arising between the technology supplier and recipient, which could not be settled amicably, should be submitted to arbitration by the International Chamber of Commerce based in Paris, France.

Although the inclusion or arbitration clauses in international contracts involving technology transactions may seem an effective provision in the event of misinterpretations of the terms and conditions of the agreements, there appear to be some positive and negative aspects to be considered by the supplier and recipient in respect to these clauses. The Hon. Mr. Justice Kerr provides an overview of the main advantages and disadvantages of solving international disputes by arbitration as opposed to the traditional method of litigation in courts of justice.

> "It is probably no over-generalising to say that businessmen generally prefer arbitration to litigation whereas lawyers do not. The reasons are easy to see. Businessmen instinctively prefer arbitration because it is private and generally more informal

because they believe it to be cheaper and quicker, and because it is, or at any rate appears, to be a friendlier means of resolving disputes than by litigation. In the course of negotiating a contract neither side will usually see anything in the least bit hostile in the incorporation of an arbitration clause. It is merely regarded as an acknowledgment of the fact that, while both sides hope that no disputes will arise, both are determined from the outset to ensure that their resolution by some external means should be as friendly as possible if this proves necessary. Even where the contract contains no provision for arbitration and where disputes have already arisen, businessmen will often still find themselves able to agree on arbitration as the most amicable way of resolving them.

Lawyers on the other hand, are often rightly sceptical about the apparent advantages of arbitration. They know that their clients will often be disillusioned in the event. Arbitral tribunals have to be paid, whereas court fees are often negligible" (Kerr, 1980: 164).

To illustrate the difficulties and resources involved in dealing with disputes derived from international contracts with arbitration provisions, Kerr mentioned the case between a German versus an English company. Their contract envisaged the design and construction of a large and complex machine plant in Germany. The German company appointed the English Queen's Counsel as their arbitrator, the English firm indicated the Canadian Queen's Counsel and the International Chamber of Commerce nominated the judge. The contractual forum was Zurich, the governing law of the agreement was English, a Danish Supreme Court judge was appointed as a neutral umpire, and the first hearings were in Copenhagen. The technical complexities were further complicated when another disagreement on the appointment of expert witnesses arose. A professor of law from Basle was substituted for the Danish judge, a Swedish technical expert was appointed but challenged by one party who finally took the case to the Swiss Federal Court. To summarise the difficulties involved in reaching a settlement in this case, after 15 years of dispute, "The arbitration is far from finished".

Considering the difficulties and the amount of resources involved in attempting to solve contractual disputes by arbitration, as observed in the above practically indefinite case, the need for preventative measures such as clearly defined terms and conditions of technological agreements seems to be an important matter for both the transferor and recipient.

Although there are no ready-made formulas for assuring the clarity of the terms and conditions of the technology transfer agreements, the United Nations Conference on Trade and Development, (United Nations, 1978) and the World Intellectual Property Organization (WIPO, 1977) have published "guidelines" for the aquisition of technology by developing countries. Apparently, these guidelines are intended to serve as frameworks for licensing agreements and other technology transactions, pointing out to the supplier and the recipient how the text of the agreement may be drawn. Other initiatives in this area include the much discussed Group of 77's proposal for an International Code of Conduct on Transfer of Technology. (United Nations, 1979; UNCTAD, 1974, 1975; Holland 1976).

In this respect, both the Japanese and Brazilian UNCTAD proposals for an international code of conduct on technology transfer, recognized the need for arbitration provisions in international contracts involving technology transactions. (Rao et al., 1976). According to their proposals, the selection of an arbitration forum to solve disputes between the technology supplier and recipient enterprises has two advantages: It may be an effective way of settling technology transfer disputes and at the same time it may act as an agency for dissiminating information among Governments, national and international enterprises, facilitating the communication between them. However, what appears be more important than selecting an arbitration forum is attempting to reduce the chances of being involved in disputes at all. Perhaps, one way to diminish the chances of getting such disputes is to make sure that the terms and conditions of the transactions are clearly defined and mutually agreed ab initio.

8. PERCEPTIONS OF THE PROCESS

8. PERCEPTIONS OF THE TRANSFER PROCESS

8.1 INTRODUCTION

The major aim of this chapter is to present the results obtained from testing the hypotheses formulated in section 3.3, and to discuss the findings related to these hypotheses. Four alternative hypotheses were developed to test whether there would be significant differences between the supplier and recipient's perceptions of individual (Hypothesis No. 1), technological (Hypothesis No. 2), organizational (Hypothesis No. 3), and environmental (Hypothesis No. 4) factors affecting the transfer process. Sections 8.2, 8.3, 8.4, and 8.5 will deal with hypotheses 1, 2, 3 and 4 respectively.

8.2 HYPOTHESIS NO. 1

Hypothesis No. 1 proposes that the supplier and recipient will differ in their perceptions of individual factors affecting the transmission of technological resources at each stage of the transfer process. Restated in the usual notation, the hypothesis was:

> H1: There are significant differences between the supplier and recipient's perceptions of individual factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

In order to test this hypothesis, a series of T-tests were conducted to determine the existence of significant differences between the supplier (Group 1) and the recipient (Group 2) at each stage of the process. The hypothesis was tested by examining the summary measures of individual factors created for each stage of the process. These summary measures consisted of the mean scores of individual's variables, namely, individual's education, training, and experience. The relevant statistics, the calculated "T-values" and 2-tail probabilities for each stage of the process are provided in table 8.1.

An analysis of the data in table 8.1 indicates that, using a 0.05 level of significance, there was no evidence to reject H1 for the initial (IND1) and intermediary (IND2) stages of the process. The same table indicates that H1 was strongly rejected for the current (IND3) stage of the process. Thus,

RESEARCH ON TECHNOLOGY TRANSFER

FILE MINID
SUBFILE GROUP1 GROUP2

T - T E S T

GROUP 1 - GROUP EQ 1.
GROUP 2 - GROUP EQ 2.

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
IND1												
GROUP 1	19	3.9333	1.325	0.304	3.65	0.009	-6.13	36	0.000	-6.13	27.17	0.000
GROUP 2	19	6.0351	0.693	0.159								
IND2												
GROUP 1	19	5.4667	1.920	0.441	6.55	0.000	-2.69	36	0.011	-2.69	23.37	0.013
GROUP 2	19	6.7368	0.750	0.172								
IND3												
GROUP 1	19	6.2667	1.978	0.454	8.57	0.000	-1.53	36	0.135	-1.53	22.15	0.140
GROUP 2	19	7.0000	0.676	0.155								

Table 8.1 T-test Statistics - Individual Variables.

hypothesis 1 was partially supported.

Considering each stage of the process separately, an examination of Table 8.1 shows that a significant difference was found for the initial, ($t = -6.13$, d.f. = 22.17, $p < 0.001$) and intermediary stage of the process. ($t = -2.69$, d.f. = 23.37, $p < 0.05$). An analysis of the data for the current stage shows that no significant difference was found. ($t = 1.53$, d.f. = 22.15, $p > 0.05$).

Figure 8.1 presents the mean scores of the summary measures of individual factors, (General Individual Factors) as perceived by each group, at each stage of the transmission of resources. Figures 8.2, 8.3, and 8.4 show separately, the mean scores of the individual variables which were utilized to derive the measure of general individual factors.

An examination of figure 8.1 reveals that the difference between the supplier and recipient's perceptions of individual factors, as suggested by the magnitude of the mean scores, was relatively greater during the first two stages of the transference. The discrepancy between their perceptions was at a maximum at the first stage of the process. In this stage, the supplier apparently perceived the general individual factors as having a moderately negative effect on the process, while the recipient indicated the opposite.

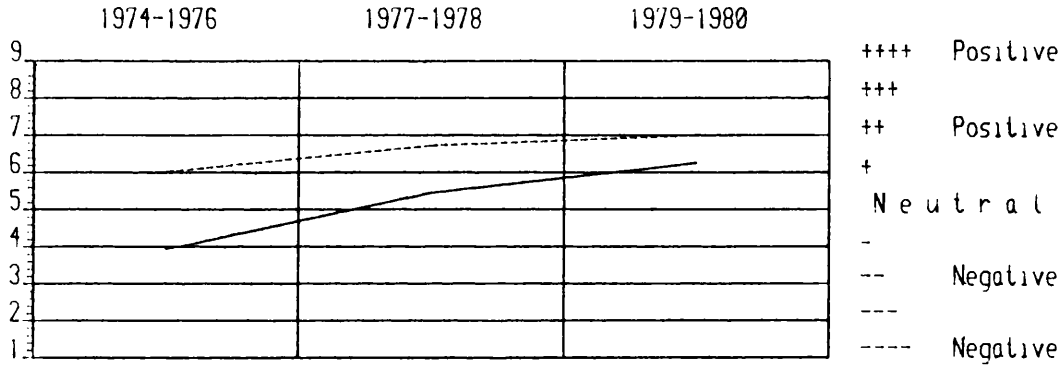


Figure 8.1 - General Individual Factors

SUPPLIER (——) AND RECIPIENT'S (----)

PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

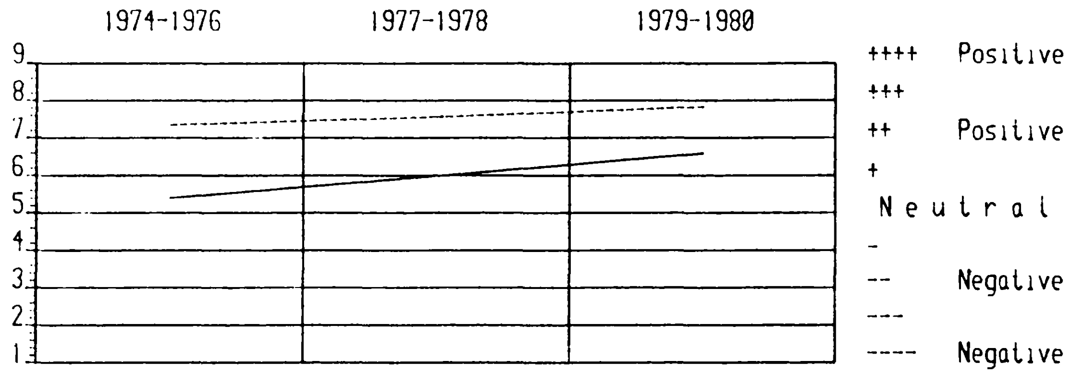


Figure **8.2** - Individuals' Education

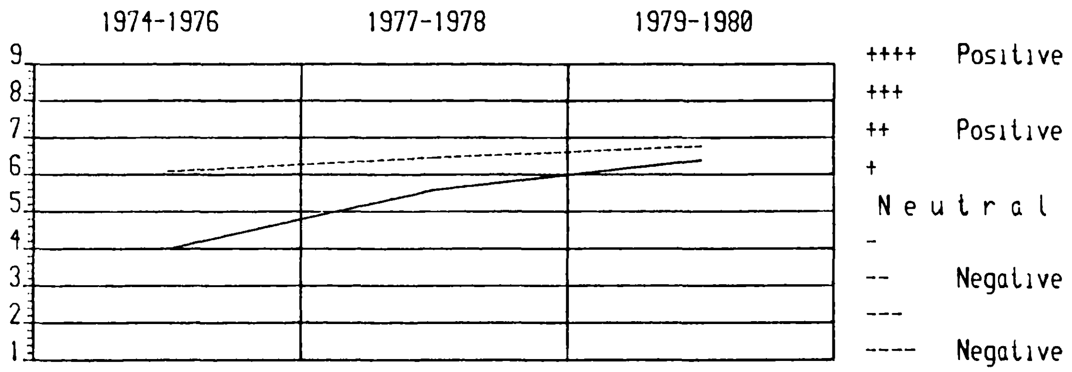


Figure **8.3** - Individuals' Training

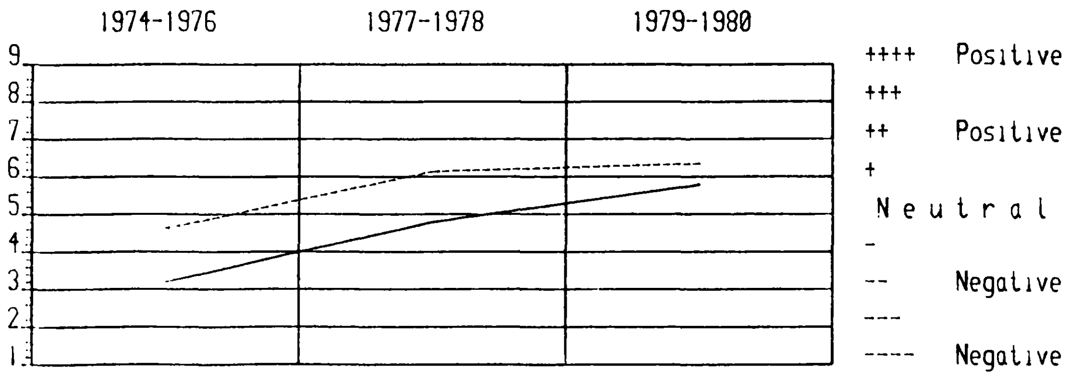


Figure **8.4** - Individuals's Industrial Experience

In the subsequent stages of the process, this difference was reduced and both parties perceived the general individual factors as producing a positive, facilitating effect in the transmission of technological resources.

Some comments provided by individual participants of the process helped to identify other factors associated with the transfer activities. For instance, two members of the supplying organization stated:

> "... a lot of people with whom we were dealing, had problems admitting a need to learn ... Probably, the key to solve this problem was getting a group of good people from Rio over into our factory in Manchester and by the time a number of them had been there for three or four months things really begun to start working ..."

> "I think that, by far the greatest success all the way through, was by the people who really got this close working together ... this means the people who came over for quite extended periods of time and got themselves immersed in what it is all about ... Some

very strong friendships have been built up".

These comments seem to support the notion that individuals are the main agents in the transfer process. (Burns, 1969; Geschka, 1974; Little, 1965; Rubenstein, 1974; Hertz, 1980). In addition, close personal relationships and informal contacts between individuals from the supplying and recipient organizations are considered as efficient mechanisms for transferring elements of technical knowledge, technical secrets and confidential information. (Allen, 1971; Allen and Cooney, 1973; Allen, 1973; Rogers, 1962; Utterback, 1975; Bass, 1974). Hardy summarizes his view on the importance of the human actors in the transfer process as follows:

> "Technology transfer is a special case of the human communication problem ... Its success depends entirely on individual human beings, not on machines or organizations" (Hardy, 1974:188-89).

Some engineers from the recipient organization provided the following comments:

> "Initially there was some incredulity in relation to our capacity to absorb the technology ... Therefore, one of our first

preoccupations was to demonstrate our previous level of technical knowledge ... Once this was achieved they begun to trust us and we started learning properly".

"The technology transfer activities helped us to identify some deficiencies in the curricula of the electronic engineering courses of our universities. For instance, we discovered that no recent graduate engineer knew how to test most of the digital hardware equipment".

"The language problems were much greater than we anticipated ... One thing is to be able to read technical books in English ... another thing is to participate in a training course in English".

The language problem mentioned by the recipient seems to illustrate Hardy's (1974) view that this is sometimes the most important barrier between the supplier and recipient. Besides the general semantic problems derived from the different cultural backgrounds, some individuals from the recipient organization also reported initial difficulties in trying to understand the unique jargon, or the coding scheme (Katz and Kahn, 1966) of the members of the supplying organisation, particularly in the field of computer engineering.

8.3 HYPOTHESIS NO. 2

Hypothesis No. 2 was formulated to determine whether there would be differences between the supplier and recipient's perceptions of technological factors affecting the transfer process at each stage of the transmission of technology. Restated in the usual notation, the hypothesis was:

> H1: There are significant differences between the supplier and recipient's perceptions of technological factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

This hypothesis was tested by analyzing the summary measures of technological factors, which consisted of the mean scores of two variables: The first was product complexity, or how the groups perceived the level of complexity of the product affecting the transfer process. The second was process complexity, or the extent to which the process utilized to assemble computers was perceived as having a positive (facilitating), neutral or negative (inhibiting) effect on the transfer process.

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FILE MINID
SUBFILE GROUP1 GROUP2

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GROUP 1 - GROUP EQ 1.
GROUP 2 - GROUP EQ 2.

VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.	POOLED VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	SEPARATE VARIANCE ESTIMATE T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
TEC1												
GROUP 1	19	5.2000	1.324	0.304	1.74	0.250	2.04	36	0.048	2.04	33.55	0.049
GROUP 2	19	4.4211	1.004	0.230								
TEC2												
GROUP 1	19	5.6000	1.572	0.361	4.81	0.002	2.71	36	0.010	2.71	25.17	0.012
GROUP 2	19	4.5263	0.716	0.164								
TEC3												
GROUP 1	19	5.7000	2.466	0.566	9.37	0.000	1.57	36	0.124	1.57	21.80	0.130
GROUP 2	19	4.7632	0.806	0.185								

Table 8.2 T-test Statistics - Technological Variables.

Table 8.2 presents the results of the t-tests conducted on the data from the two groups to determine the existence of significant differences for the three stages of the process. Using a 0.05 level of significance, an analysis of table 8.2 indicates that there was no evidence to reject H1 for the initial (TEC1) and intermediary (TEC2) stages of the process. For the current stage (TEC3) H1 was strongly rejected. Therefore, hypothesis 2 was partially rejected.

An examination of table 8.2 shows that significant differences were found between the supplier and recipient's perceptions of technological factors at the initial, ($t = 2.04$, d.f. $= 36$, $p < 0.05$) and intermediary stages of the process, ($t = 2.71$, d.f. $= 25.17$, $p < 0.05$). No significant difference was found for the current stage of the process. ($t = 1.57$, d.f. $= 21.80$, $p > 0.05$) Figure 8.5 summarizes the supplier and recipient's perceptions of technological factors at each stage of the transfer process. The variables which were combined to generate the summary measure of technological factors are shown separately in Figures 8.6 and 8.7.

An examination of figure 8.5 suggests that, in general, the recipient perceived technological factors as exerting a neutral, tending to negative, influence on the process, while the supplier reported

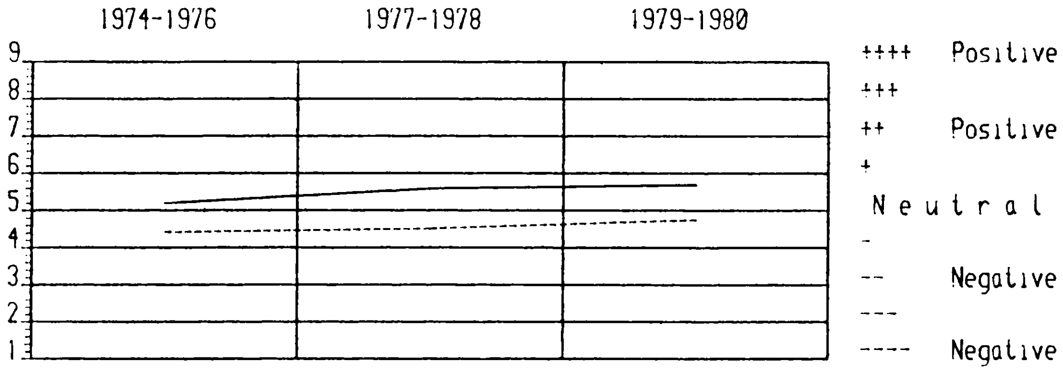

Figure **8.5** - General Technological Factors

SUPPLIER (——) AND RECIPIENT'S (----)

PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

the opposite. According to the same figure, the discrepancy in their opinions was at a maximum in the second stage of the process. Although both the supplier and recipient perceived the complexity of the process (Figure 8.7) during the three stages as having a relatively neutral (tending to positive) effect on the process, the complexity of the product (Figure 8.6) was seen as exerting a slightly negative, impeding effect. Thus, these results appear to suggest that technology per se, (Baranson, 1966, 1969; Seurat, 1976, Hertz, 1980) was considered as a constraint in the transfer process, while the process used to make computers, from the separate hardware modules, mechanical and electromechanical components was not viewed as such. In fact, the actual process of assembling the various elements and modules that go into a computer central processing unit does not appear to be complex, compared with the high technology involved in manufacturing the components themselves. Several modules involved in assembling computers are 'plug in packages'. The recipient basically follows the specifications and testing procedures provided by the technology-supplier, assembling the various printed circuit boards, cables, power unit, and other electromechanical, mechanical and microelectronic parts and components, into the finished product.

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

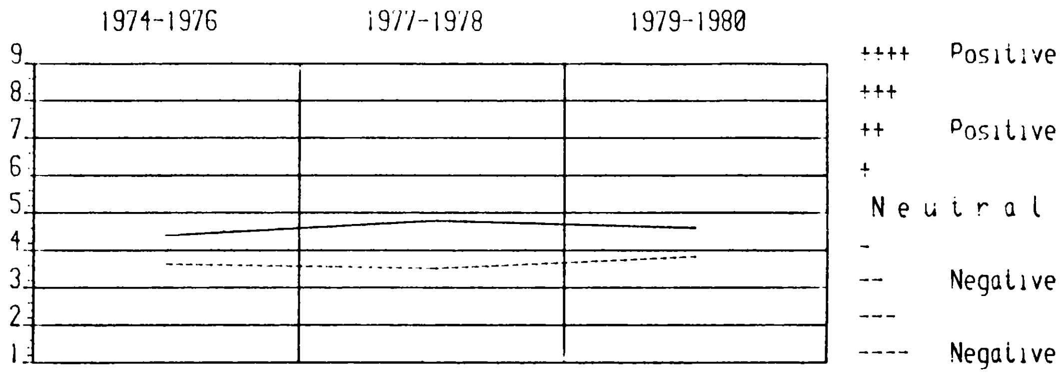

Figure **8.6** - Product Complexity

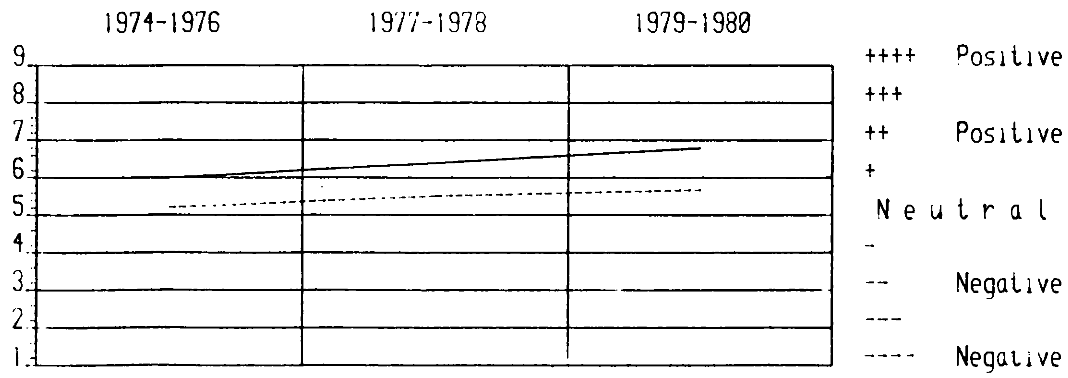

Figure **8.7** - Process Complexity

8.4 HYPOTHESIS NO.3

Hypothesis No. 3 suggests that the supplier and recipient will differ in their perceptions of organizational factors affecting the transmission of technology at each stage of the transference. Restated for the purpose of this analysis, the hypothesis was:

> H1: There are significant differences between the supplier and recipient's perceptions of organizational factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

This hypothesis was tested by examining the summary measures of organizational factors, which consisted of the mean score of the following variables:

a) The degree of ownership by the technology-supplier;

b) The availability of local inputs for production;

c) The availability of management resources;

d) The availability of engineering and technical resources;

e) The availability of other human resources.

Thus, the summary measure of organizational factors represents, basically, an index of the extent to which the respondents perceived these variables exerting a negative (impeding), neutral, or a positive (facilitating) effect on the transmission technological resources, at each stage of the process.

To determine the existence of significant differences between the groups, a series of t-tests were conducted on the data. The relevant statistics, "t"-values and 2-tail probabilities are provided in table 8.3.

An analysis of table 8.3 shows that, using a 0.05 level of significance, the hypothesis was supported for the initial (ORG1) and current (ORG3) stages of the process. H1 was rejected for the intermediary (ORG2) stage of the transfer. Thus, in general, hypothesis No. 3 was partially supported.

An examination of table 8.3 indicates that significant differences were found between the supplier and recipient's perceptions of organizational factors at the initial, ($t = -4.44$, d.f. = 25.82, $p < 0.001$) and current ($t = -2.42$, d.f. = 33.33, $p < 0.05$) stages of the transference. No significant difference was

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FILE MINID
SUBFILE GROUP1 GROUP2

T - T E S T

GROUP 1 - GROUP EQ 1.
GROUP 2 - GROUP EQ 2.

							POOLED VARIANCE ESTIMATE			SEPARATE VARIANCE ESTIMATE		
VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
ORG1												
GROUP 1	19	4.4000	1.184	0.272	4.38	0.003	-4.44	36	0.000	-4.44	25.82	0.000
GROUP 2	19	5.7368	0.566	0.130								
ORG2												
GROUP 1	19	5.0000	1.064	0.244	4.78	0.002	-1.80	36	0.080	-1.80	25.22	0.083
GROUP 2	19	5.4842	0.487	0.112								
ORG3												
GROUP 1	19	5.0800	0.764	0.175	1.79	0.227	-2.42	36	0.021	-2.42	33.33	0.021
GROUP 2	19	5.6105	0.571	0.131								

Table 8.3 T-test Statistics - Organizational Variables.

found for the intermediary ($t = -1.80$, d.f. = 25.22, $p > 0.05$) stage of the process.

Figure 8.8 exhibits the supplier and recipient's summary measures of organizational factors for the three stages of the transfer process. From data presented in figure 8.8 it seems that, once again, the diffference between the perceptions of the groups was more accentuated, at the initial stage of the transfer. According to the recipient, general organizational factors seemed to exert a neutral to positive influence on the first stage. On the other hand, the supplier perceived organizational factors as producing a neutral to negative effect on the same stage of the process. Regarding the subsequent stages of the process, their perceptions, as suggested by the mean scores, were relatively congruent, and both parties appeared to perceive that organisational factors had little effect.

MANAGEMENT RESOURCES

Considering the variables which might have influenced the process in isolation, reference to figure 8.9 reveals a relatively strong difference of perception as to the extent to which the availability of management resources in the recipient organization affected the transmission of resources. The supplier suggested that this variable acted as a constraint to

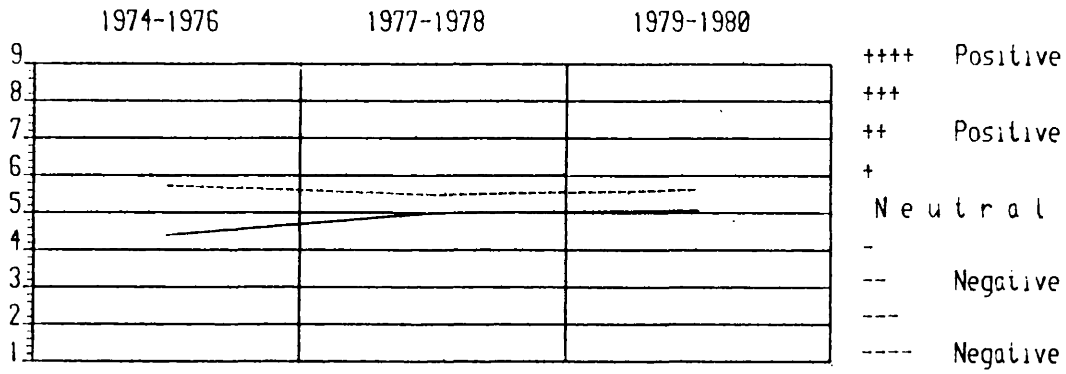

Figure **8.8** - General Organizational Factors

SUPPLIER (——) AND RECIPIENT'S (----)

PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

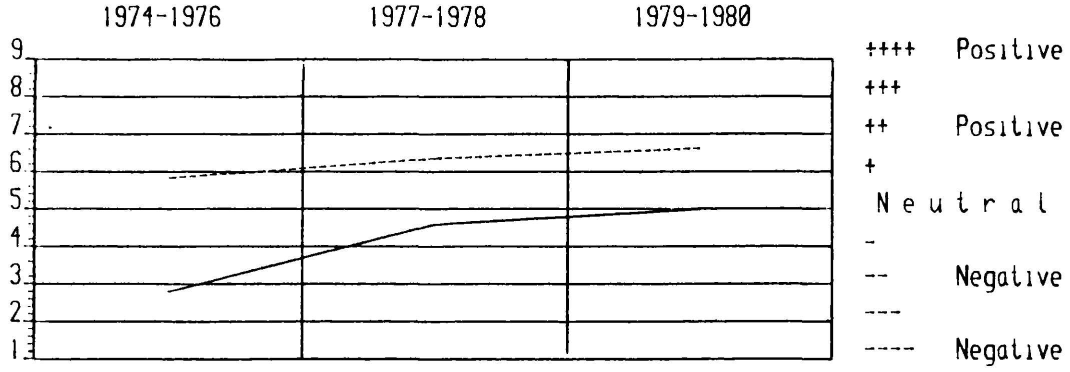

Figure **8.9** - Management Resources

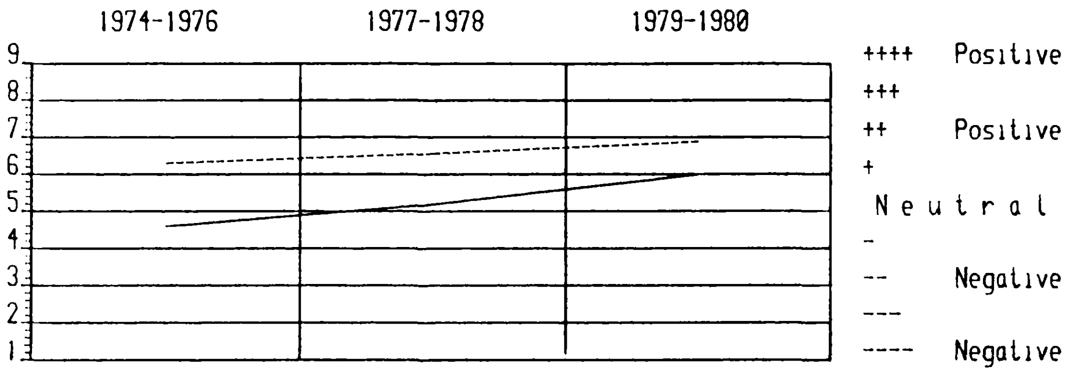

Figure **8.10** - Engineering and Technical Resources

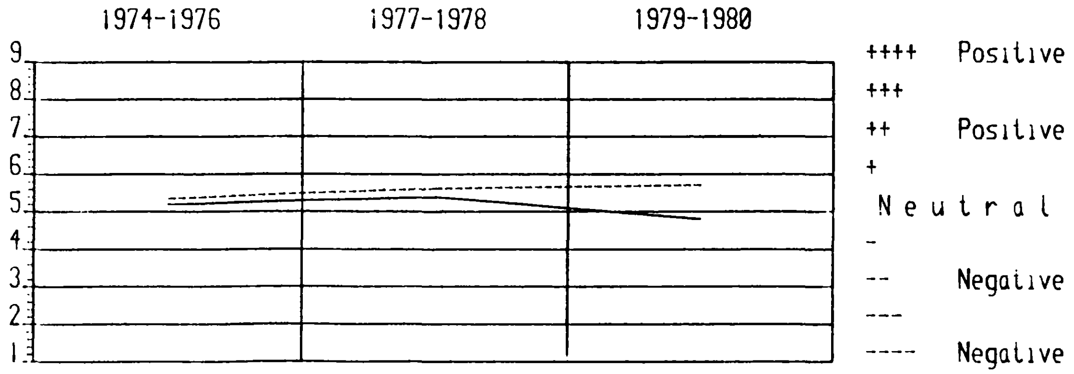

Figure **8.11** - Other Human Resources

the process, particularly in the first stage, while the recipient considered it not an impeding force, but as a neutral, practically positive factor during the three stages of the transfer. The supplier's view appears to support Wallender's (1979) contention that the lack of management resources is one of the major constraints to successful technology transfer activities in developing countries. This point seems to be well recognized in the literature. (Seurat, 1976; Myrdal, 1981, Cooper and Sercovitch 1971; Baranson, 1969).

ENGINEERING AND TECHNICAL RESOURCES

As to the availability of engineering and technical resources, (Figure 8.10) the supplier considered it as a slight constraint at the first stage of the process. In the subsequent stages it was viewed as a neutral, tending to positive factor. In general, the recipient seemed to indicate that this variable exerted a moderately positive influence on the process.

OTHER HUMAN RESOURCES

In relation to the availability of other human resources (Figure 8.11), such as skilled and semi-skilled personnel, both the supplier and recipient appear to suggest that in general, it was considered as a neutral variable. One interviewee, however, commented that,

> "We found it difficult to recruit and train the skilled labour that we needed... .
>
> This is one thing that we were usually short of in Brazil. You have the university graduates and manual labour, but it was the skilled labour in between that it was always so difficult to get".

DEGREE OF OWNERSHIP BY SUPPLIER

As regards the perceptions of the extent to which the degree of ownership by the transferor acted as a positive, neutral or negative factor in the transmission of resources, reference to figure 8.12 reveals some divergence between the supplier and recipient's views in the first stage of the transfer. The former indicated that this factor exerted a neutral tending to positive, influenceon all stages of the process, while the latter emphasized its positive aspects in the first stage of the process.

The actual levels of supplier's participation in the capital structure of the recipient enterprize are illustrated in figure 8.14. Apparently, the recipient perceived the relatively high levels of

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

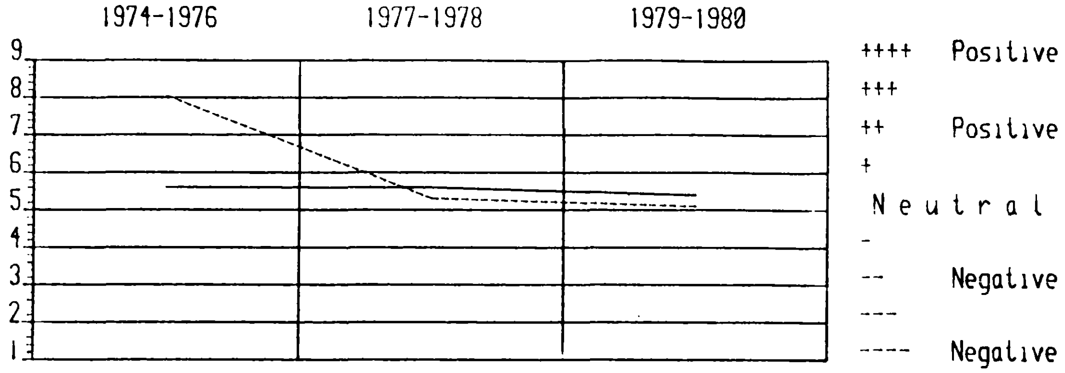

Figure **8.12** - Degree of Ownership by Supplier

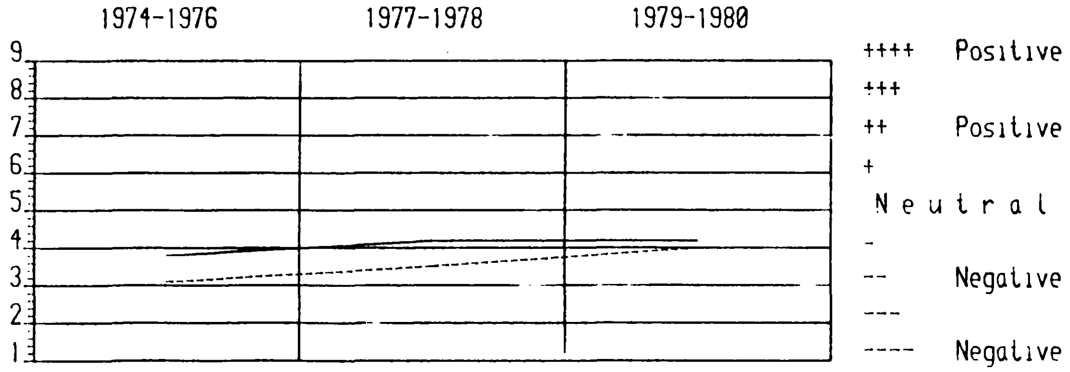

Figure **8.13** - Local Inputs For Production

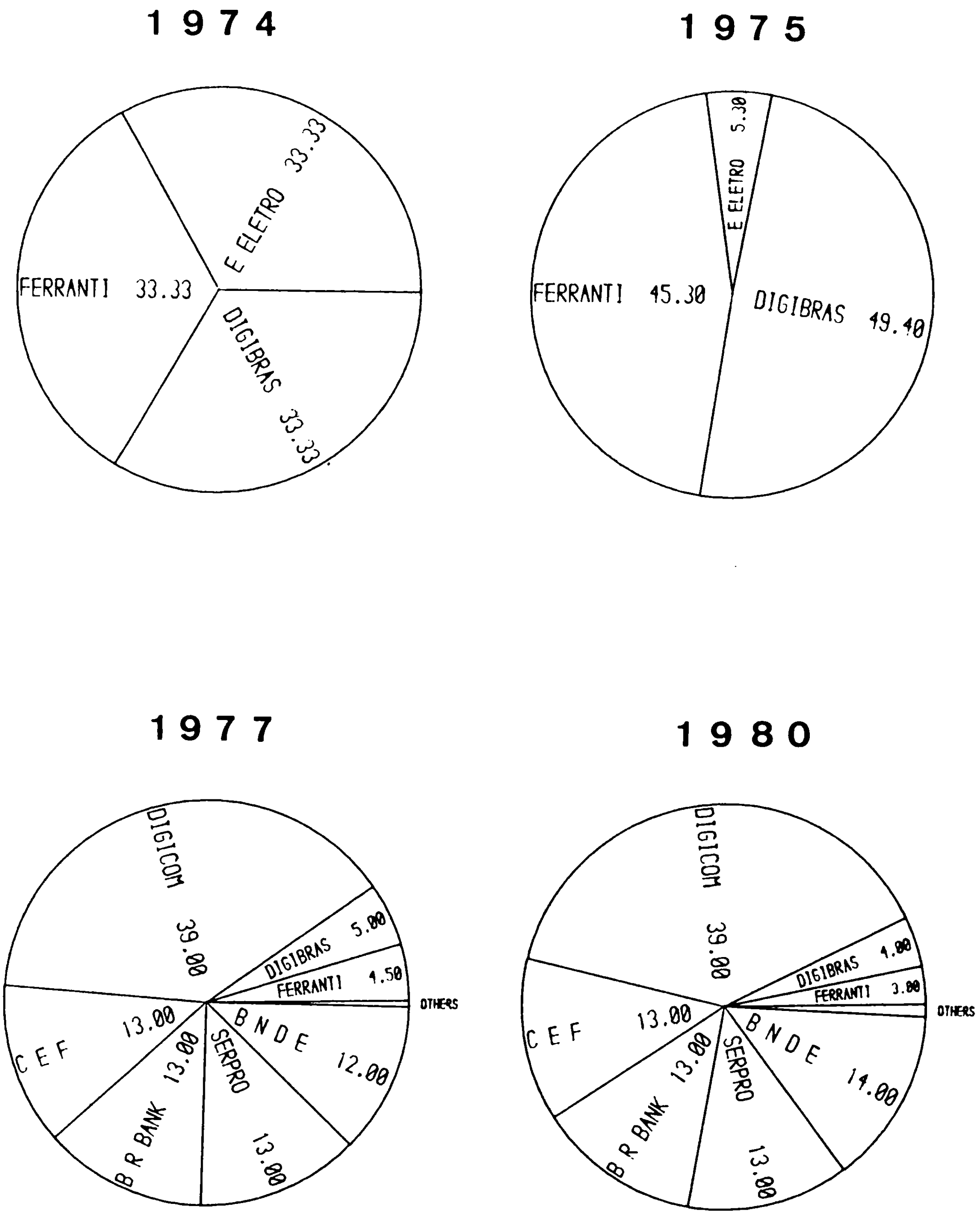

Figure 8.14 Supplier's participation in the Recipient's Capital Structure.

supplier's participation at the initial stage as a positive, facilitating factor in the transfer process. The literature suggests the existence of a trade-off between the extent of technology transferred and the degree of capital ownership by the supplier. (Balasubramanyam, 1973, United Nations, 1975; Bredo 1974; Vernon, 1972).

LOCAL INPUTS FOR PRODUCTION

Regarding the availability of local inputs for production, figure 8.13 suggests that both the supplier and recipient perceived this variable as a disturbing, negative factor, in its first factor, in the first stage of the transfer. In the subsequent stages of the process the recipient considered it as a slightly negative factor while the recipient rated it as exerting a neutral, tending to negative, effect on the transmission of technology. In general, both parties seemed to recognize the problem of the lack of adequate sources of supplies and ancilliary services in the local environment. (Livingstone, 1975; Baranson 1969). In addition, the recipient provided an illustration of production problems caused by the local supplier of printed circuit boards, i.e. sometimes, it took more than 120 days to deliver an order. The relatively small size of the industrial market for computer parts and components, and the level of technological development of local suppliers appear to be further constraints to the anticipated rates of "Brazilianization" of the product. Some parts and components needed for production, such as multi-layer circuit boards, and other electro-electronic and electro-mechanic components are simply unavailable in the local environment. Apparently, this forces the recipient, among other things to be dependent on foreign sources of supply and face legislative, financial and administrative difficulties associated with obtaining foreign exchange, import licenses, etc.

Thus, there appears to be a vicious circle associated with the lack of local supplies, materials and services. Assuming that the industrial market for computer parts and components in Brazil is not large enough to allow economies of scale, a priori, local firms may not be encouraged to acquire new technologies and capabilities required for producing some parts and components locally. And, if they do not acquire these technologies and capabilities, the market is likely to remain dependent upon foreign sources, etc. Perhaps, one possible way out of the "vicious circle" is some form of co-operation between foreign and local enterprises, following the IBM example. Since 1972, the Brazilian subsidiary of International Business

Machines is producing a variety of computer equipment and peripherals in its Sumare plant in Sao Paulo. Instead of importing a number of computer parts and components IBM/BRAZIL opted for what Livingstone (1975:125) calls a "very positive attitude of encouraging and ... giving advice to local suppliers" Within two years of a supplier development programme, with the participation of its French subsidiary, IBM transmitted to a Brazilian supplier the technological resources and elements of knowledge needed to produce integrated circuit boards. A similar arrangement was made for producing capacitors, transformers, cables, conductive paint for computer frames, etc. As a result of this supplier development programme, IBM/Brazil presently acquires locally a variety of computer parts and components which otherwise would have been imported.

OTHER FACTORS

Other organizational problems associated with the transfer process were revealed through the open discussions with the executives, engineers and managers directly involved in the transmission of technological resources. For instance, some executives suggested that part of the initial difficulties were due to the fact that they were not transferring technology to an existing organization but to something which was being structured as they were attempting to transmit the elements of technology. One of the executives stated:

> "At the same time we were trying to transfer the technology, they were trying to recruit the people to make use of it ..."

Thus, as the technology was being transmitted, individuals were being recruited into Cobra and not into very clear locations within Cobra, because it did not have an organizational structure, initially. In terms of Wallender's (1979) hypothesized stages of user firm development for receipt of technology presented in table 2.1, chapter 2, the presence of a basic organizational structure in the recipient organization is a pre-requisite for the acquisition of technological resources. Therefore, the lack of an organizational structure may be viewed as a critical problem at the initial stage of the process. According to Wallender's view, since the eight stages of user firm development are cumulative, many technology transfer projects, such as the organization of American States (OAS) Pilot Project and the United States National Technical Information System are mismatched to the needs of the user because they failed to identify the relative level of development of the recipient organization and started to transmit technology directed at higher levels. In general, the literature seems to recognize that the lack of an adequate organizational structure in the recipient firm may produce negative, inhibiting effects on the transmission of technological resources on an enterprize-to-enterprize basis. (Wallender, 1979; Seurat, 1976; Rogers, 1972; Weil, 1980).

The literature on international technology transfer suggests that organizations which have some experience in acquisition of technology are more likely to benefit more quickly from other technology transfer programs. (Bass, 1974; Teece, 1976; Wallender, 1979; Stewart, 1977). However, some comments provided by one manager from the technology-supplying organization appear to suggest that past experience in technological transactions is an important variable in the transfer process for both the technology-receiving and supplying organizations. This manager explained that, although the company had sold technologically sophisticated products to many other nations,

> "...selling abroad is different from transferring technology..."
>
> "Yes, it is true to say that we were learning as well as the Brazilians".

Apparently, the Braziliar experience in international technology transfer produced, for the supplier, what Thomas (1977) calls a learning opportunity. The same manager noted that they were about to do another licensing agreement for the manufacture of computers with a foreign nation, and that the Brazilian technology transfer experience was being helpful in the negotiations . He observed that,

> "In talking with the ... we have been making a great thing of the experience we have had in Brazil. If we do a deal with ... the situation is very similar. We know where to start and a lot of things to avoid".

Another problem associated with the technology transfer activities from one organization to another was the question of conflicting roles of some individual participants in the process. One manager from the supplying organization explained:

> "Although I became a COBRA employee, they thought that my sole purpose was to look after Ferranti's interests ... and I could not persuade several of these people that I was a Cobra man. Okay, Ferranti's interests had to be looked after, but as part of what

> was happening, not as my main function. Several of them never really believed that I was a Cobra man, they simply regarded me as a Ferranti man, looking after Ferranti's interest. This was another problem."

This seems to be an example of what Kahn et al (1964:19) call a role conflict in organizational settings, which arises from the "simultaneous occurrence of two (or more) sets of pressures such that compliance with one would make more difficult compliance with the other".

In terms of Pearlmutler's (1969) typology of conflict handling situations, this manager was presumably attempting to take a geocentric or balanced attitude towards the local and home office's interests. However, considering this role conflict in a broader perspective, it appears to be a manifestation of a wider problem, namely, the latent conflict of interests (Fayerweather, 1969; Quinn, 1969; Gabriel, 1972; Hardy, 1974; Hertz, 1980) between the objectives of the technology-supplying and recipient organizations.

8.5 HYPOTHESIS NO. 4

Hypothesis No. 4 proposes that individuals from the technology-supplying and receiving organizations will differ in their perceptions of environmental factors affecting the transfer of technology at each stage of the process. Stated in a testable form the hypothesis was:

> H1: There are significant differences between the supplier and recipient's perceptions of environmental factors affecting the transmission of technological resources at the initial, intermediary and current stages of the process.

For testing hypothesis No. 4, the summary measures of environmental factors for each group were utilized. These consisted of the mean score of fifteen variables, representing an index of the extent to which individuals perceived the set of macro-environmental variables exerting a negative, neutral or positive influence on the process of transmitting technology from one organization to another. The summary measures comprised the following variables:

a) National ideology;

b) National view toward foreigners;

c) The formal educational structure;

d) The informal educational structure;

e) Political climate;

f) Technology transfer regulations;

g) Exchange control regulations;

h) Import regulations;

i) Royalty and profit remission regulations;

j) Economic conjuncture;

k) General balance of payments position;

l) The market environment;

m) The industrial infrastructure;

n) The physical infrastructure;

o) The technological infrastructure.

In order to test this hypothesis, a series of t-tests were performed on the data for each stage of the process, to determine whether there would be significant differences between the technology-supplying and recipient groups. Table 8.4 presents the

RESEARCH ON TECHNOLOGY TRANSFER

FILE MINID
SUBFILE GROUP1 GROUP2

- - - - - - - - - - - - - - T - T E S T - - - - - - - - - - - - - -

GROUP 1 - GROUP EQ 1.
GROUP 2 - GROUP EQ 2.

							Pooled Variance Estimate			Separate Variance Estimate		
VARIABLE	NUMBER OF CASES	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.	T VALUE	DEGREES OF FREEDOM	2-TAIL PROB.
ENV1												
GROUP 1	19	4.5467	0.959	0.220	10.33	0.000	-2.96	36	0.005	-2.96	21.45	0.008
GROUP 2	19	5.2281	0.298	0.068								
ENV2												
GROUP 1	19	4.5867	0.932	0.214	10.18	0.000	-3.99	36	0.000	-3.99	21.50	0.001
GROUP 2	19	5.4807	0.292	0.067								
ENV3												
GROUP 1	19	4.8000	1.246	0.286	12.12	0.000	-3.33	36	0.002	-3.33	20.95	0.003
GROUP 2	19	5.7895	0.358	0.082								

Table 8.4 T-test Statistics - Environmental Variables.

results of the t-test analysis for the three stages of the process, the relevant statistics, the 2-tail probabilities.

An analysis of table 8.4 indicates that, at the 0.05 level of significance there was no evidence to reject the alternative hypothesis for the initial (ENV1) intermediary, (ENV2) and current (ENV3) stages of the transfer process. Thus, the hypothesis No. 4 was supported. Significant differences were found between the supplier and recipient's perception of macro-environmental factors affecting the transmission of technological resources for the three stages of the process.

Figure 8.15 presents the supplier and recipient's summary measures of general environmental factors for the three stages of the transference. An examination of figure 8.15 suggests that, in general, based on the mean scores, the supplier perceived macro-environmental factors exerting a neutral, tending to positive, influence on the transfer process. On the other hand, the recipient group indicated that the same factors were perceived as having a neutral, tending to negative, effect on the transmission of resources. The differences between the mean scores were smaller in the first stage of the process and slightly larger in the

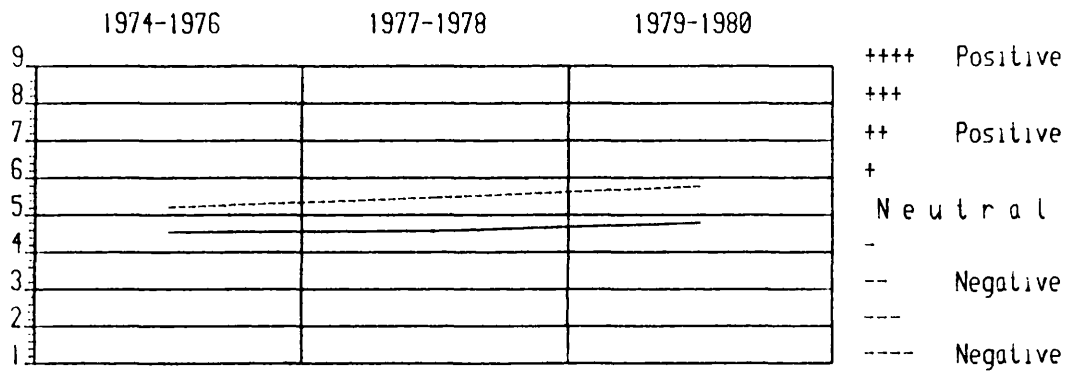

Figure **8.15** - General Environmental Factors

SUPPLIER (——) AND RECIPIENT'S (----)

PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

subsequent stages. Considering the magnitude of the mean scores, the groups differed in their perceptions of general environmental factors in all stages of the transfer.

NATIONAL IDEOLOGY AND POLITICAL CLIMATE

Figure 8.16 presents the supplier and recipient's perception of the extent to which the general collective ideology of the nation, or "the systematic body of economic political and ethical doctrines" (Livingstone, 1975:192) affected the transfer process. Reference to figure 8.16 suggests that, in the first two stages of the process, this variable was not perceived by the supplying and recipient groups as a major constraint to the transfer activities. In the third stage of the process, however, the differences between the supplier and recipient views were slightly more accentuated. The supplier rated this variable as exerting a moderately positive effect, while the recipient viewed it as a neutral, tending to negative factor.

Regarding the general attitude towards foreiners (Figure 8.17), the transferor and transferee seemed to indicate that this variable exerted a neutral, slightly negative, effect on the first stage

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

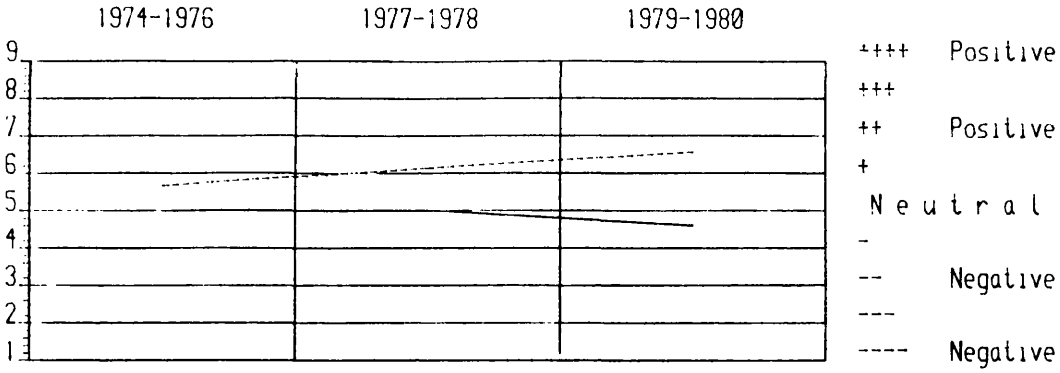

Figure **8.16** - National Ideology

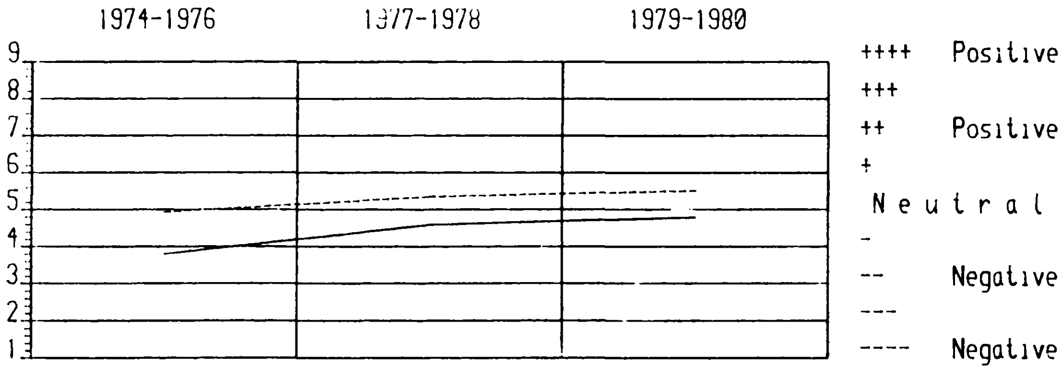

Figure **8.17** - General Attitude Toward Foreigners

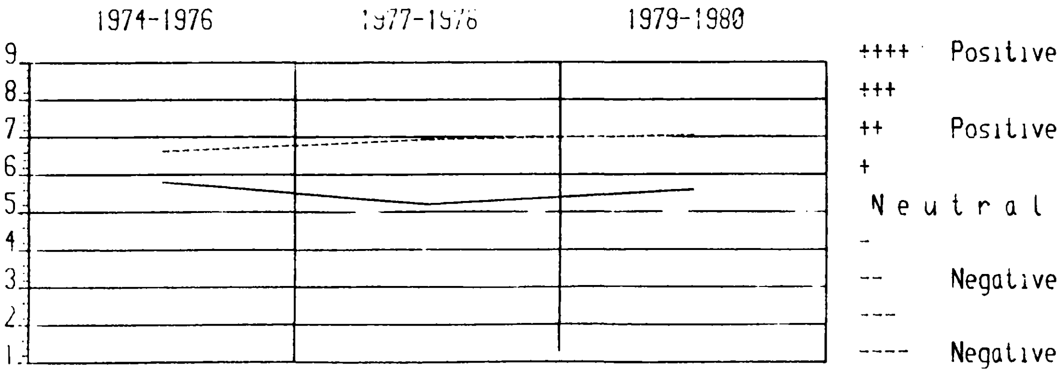

Figure **8.18** - Political Climate

of the process. In the subsequent stages, both parties appeared to suggest that the general attitude towards foreiners had little effect.

Figure 8.18 presents the perceptions of the supplier and recipient concerning the political climate. In general, the supplier seemed to perceive that political factors produced a relatively neutral, tending to positive effect. The recipient appeared to suggest that political factors exerted a moderate, positive influence on the process.

The Brazilian political regime has been relatively stable since 1967, as compared with other Latin American countries. As a Financial Times (1979) survey stated, "Brazil is emerging from 14 years of military rule, during which time the Brazilian economic miracle was performed. The economy reached growth rates of 10 percent per annum at the turn of the decade and this might have continued at this rate but for the 1973 oil crisis. However, the cost of the miracle in social terms was high". Despite these relatively high economic growth rates, Brazil has been facing a series of socio-economic and political problems such as growing pressures for political liberalization, a highly concentrated income distribution, the rising costs of petroleum, deficits in the balance of trade, etc. These problems usually generate tensions and pressures for change. In general terms, one of the first signs of change has been a trend towards promoting a gradual political liberalization of the country. (National Westminster Bank, 1979). In other words, as one veteran politician observed, "we are making the transition to a real democracy" (Financial Times, 1978). Since the third stage of the process (1979-1980) coincided, with the gradual liberalization of the regime, perhaps the consideration of this event will clarify the analysis of the factors which may have affected the transmission of technology, as perceived by the supplier and recipient.

EDUCATIONAL INFRASTRUCTURE

The supplier and recipient's perceptions of the extent to which the formal and informal educational infrastructure affected the transfer process are presented in figures 8.19 and 8.20, respectively. Both the supplier and recipient seemed to suggest that, in general, the network of schools, and universities provided a positive effect on the transference of technological resources. Regarding the network of training establishments providing informal education, in the initial stage of the transfer process, it was viewed as a neutral, tending to negative factor, by both the supplier and the recipient. In the subsequent

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

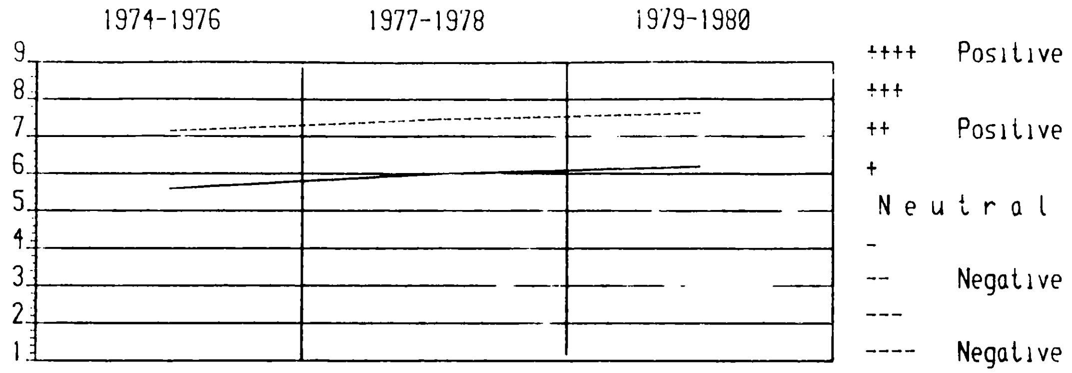

Figure **8.19** - Formal Educational Infrastructure

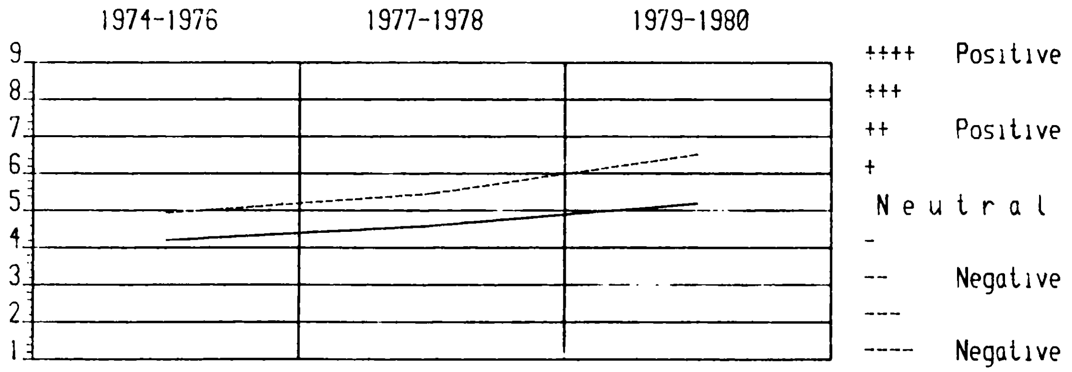

Figure **8.20** - Informal Educational Infrastructure

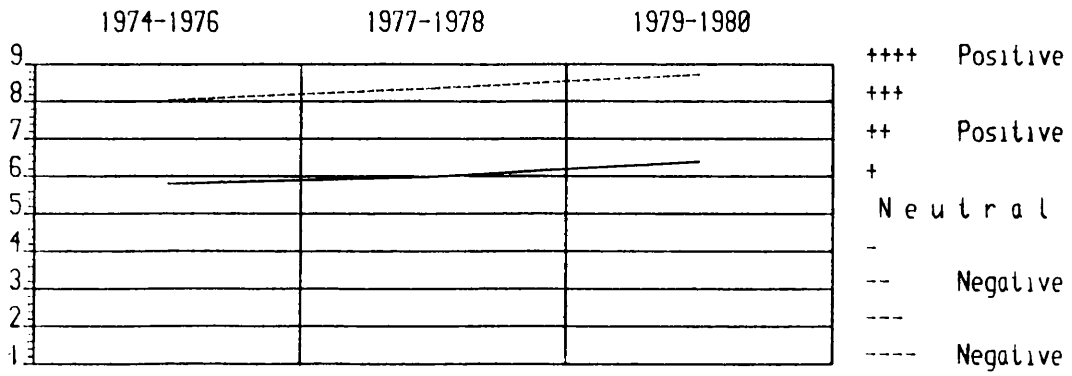

Figure **8.21** - The Market Environment stages of the transfer, this variable was seen as exerting a slightly more positive influence in the process.

THE MARKET ENVIRONMENT

Figure 8.21 shows the supplier and recipient's perceptions of the extent to which the market environment acted as a positive, neutral or negative factor in the transfer process. An examination of the mean scores suggests some contrast in perceptions of the market environment in the three stages of the transference. Although both parties seemed to perceive this variable exerting a positive, inducing effect on the transfer of technological resources, the magnitude of the mean scores indicate that the recipient perceived the influence of the market environment as considerably more positive than the supplier.

According to Strasser (1974) the possibility of transferring technology successfully depends on the approach utilized. He distinguishes between the "market pull" versus the "technology push" approach. The market pull approach represents basically a marketing approach. Technology is introduced as a response to a market demand and in an attempt to meet the needs of the customer. In contrast, the technology push approach advocates the transmission of technology independently of the needs of the user. Strasser suggests that the market pull approach tends to be more successful than the other, despite being more difficult and the time consuming, since it requires an understanding of the market signals and an assessment of the users' needs.

Considering the relatively high growth rates of the Brazilian computer market, particularly the minicomputer segment, as discussed in chapter 5, the market environment appeared to have produced a "market pull" effect on the transfer process. According to Wallender (1979) organizations which acquire technology to take advantage of market opportunities usually have greater chances of success in technology transfer activities than those which respond to other problems. In general, the literature seems to support the notion that the size of the market is a key variable in the process of transferring industrial technology for the establishment of production facilities. (Vernon, 1966; Baranson, 1966; Stobaugh, 1969; Wells, 1972; Livingstone, 1975; Myrdal, 1981).

REGULATORY FRAMEWORK ON TECHNOLOGY TRANSFER

The perceptions of the extent to which national technology transfer regulations affected the

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

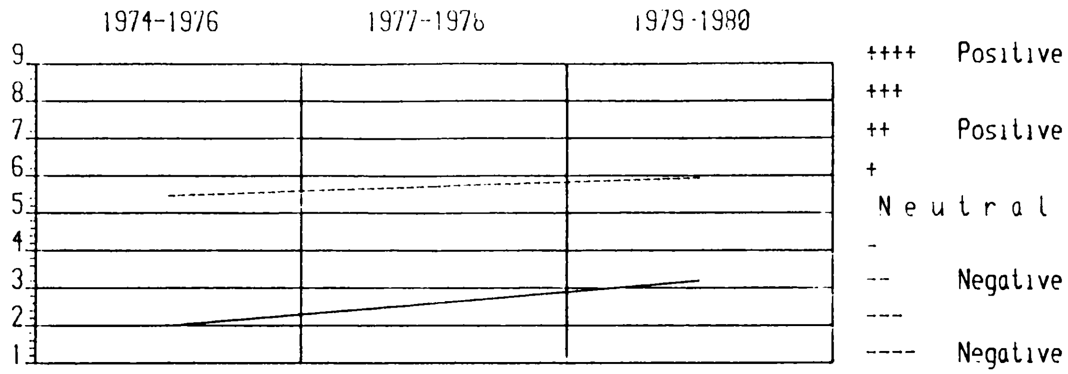

Figure **8.22** - Technology Transfer Regulations

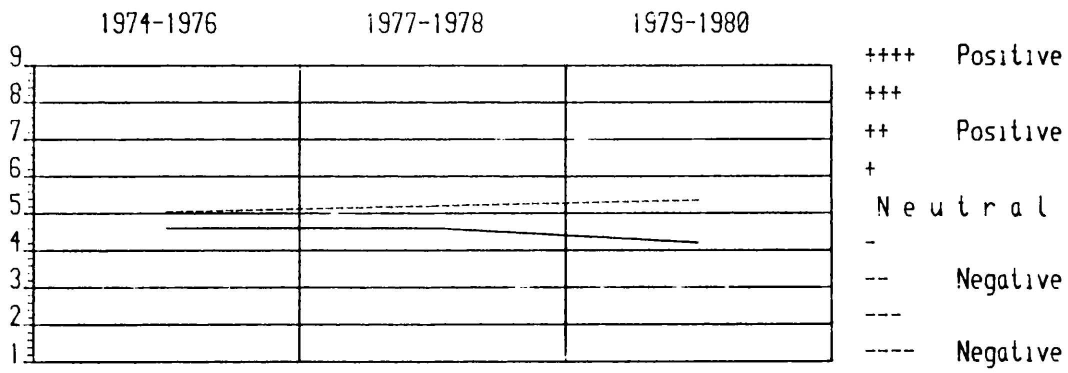

Figure **8.23** - Exchange Control Regulations

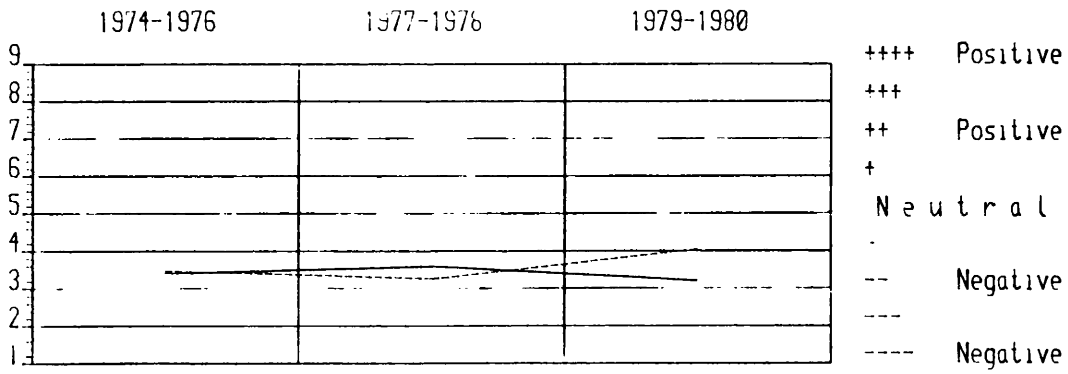

Figure **8.24** - Import Regulations

transfer process are depicted in figure 8.22. An examination of the supplier and recipient's mean scores suggest a divergence of perception regarding the influence of this variable in all three stages of the process. The supplier seemed to perceive the national regulatory framework on technology transfer transactions exerting a negative, hindering, effect on the transference of technology, particularly in the initial stages of the process. The recipient however, appeared to indicate that the regulatory framework produced basically a neutral impact on the transmission of resources.

In 1974, when Cobra was established and the first contacts with the National Institute of Industrial Property (INPI) were made, there was not an explicit national policy with regard to technology transfer transactions. (Figueredo, 1972) Thus, licensing agreements and contracts involving proprietary rights and royalty payments were analyzed on a case-by-case basis by both the Central Bank of Brazil and the INPI. Presumably, this involved considerable delays and margins for different interpretations of the web of laws, decrees and administrative acts regulating the matter. The following comments may illustrate some difficulties perceived by the supplier in the initial stages of the transfer process.

> "We had a whole batch of problems associated with getting agreement to the transfer of technology contract ... Initially INPI were providing problems. The question of whether we would be allowed to be paid anything at all for what we were providing ..."

> "In fact, the whole thing very nearly failed to happen completely because of the difficulties that we had ... They were changing their minds about what they wanted to do".

> "If the Navy had not been involved I don't think Cobra would have ever come into existence".

THE GENERAL ECONOMIC CONJUNCTURE

In general, it seems that the supplier and recipient perceived the overall state of the economy (Figure 8.26), the balance of payments position (Figure 8.27), and import regulations (Figure 8.24) as causing some difficulties to the technology transfer process. As to the influence of exchange control (Figure 8.23) and royalty and profit remission regulations, (Figure

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

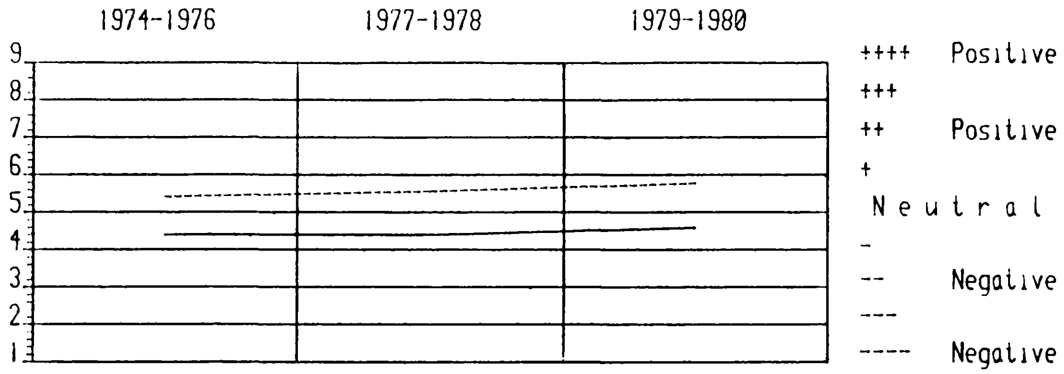

Figure **8.25** - Royalty and Profit Remission Regulations

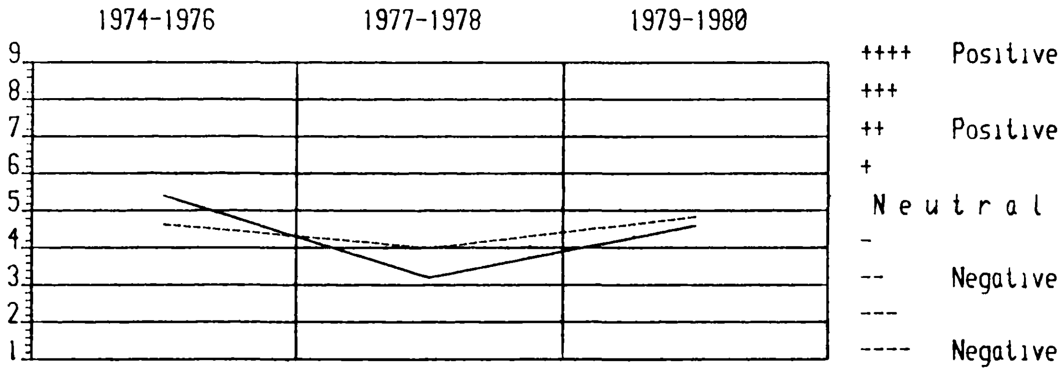

Figure **8.26** - Economic Conjuncture

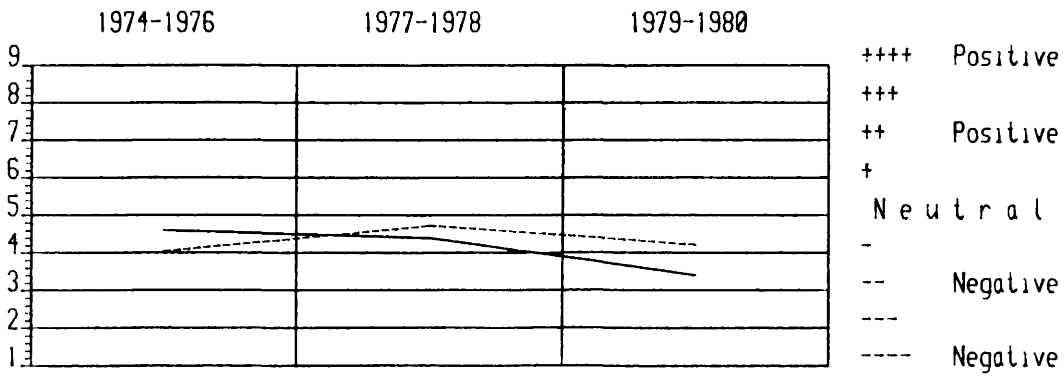

Figure **8.27**- General Balance of Payments Position

8.25) in the supplier's view they appeared to have produced a neutral, tending to negative effect on the transfer process, while the recipient considered them as neutral, tending to positive, variables. These factors will be considered in the context of the changes in the Brazilian economy since 1974.

Since 1974, the Brazilian economy began to reflect some problems caused by the four-fold increase in international petroleum prices, at the end of 1973. In 1974, the domestic production of crude oil covered only 21.3 per cent of the consumption. Thus, as an oil-importing country Brazil suffered the impact of the sharp rise in world petroleum prices. Among other things, as a result of the increase in oil prices, the following changes have been observed in the economy.

a) In 1974, an unprecedented deficit in the balance of trade. (US$ 4.5 billion). The current account deficit more than tripled and Brazil's balance of payments registered an overall deficit of approximately 1 billion dollars. Between 1974 and 1980, the balance of trade continued in deficit, except for a small surplus registered in 1977. (Figure 4.3)

b) In 1974, a sharp decline in the Gross Domestic Product and the real output growth rate of the industrial product, as shown in Figure 4.1. The real output growth rates associated with commerce, transport and communications also fell considerably. (Figure 4.2)

c) A return to the relatively high inflation rates. The general price almost doubled, from 15.1% in 1973 to 28.7% in 1974. As shown in table 4.3 the pattern of decline in the inflation rates achieved between 1965 and 1973 was broken and between 1974 to 1980, the general price index rose considerably.

In an attempt to adjust the economy to the realities of the world oil crisis, and to reduce the deficit of the deteriorated balance of trade, the Federal Government designed a series of monetary, fiscal and administrative corrective measures. Among these, the following import restrictions were enacted:

a) Higher import tariffs. Since 1974, an increase in import tariffs for 3,503 selected products, varying from 30 to 100 per cent of the FOB value. Most of the products affected were consumer goods. (Decree-Laws numbers 1334, 1364, 1421, 1501, 1589 and 1685).

b) Compulsory deposit for imports. In 1975, through resolutions 331 and 354, the Central Bank of Brazil subjected the issue of import licenses to the deposit in cruzeiros, of the sum corresponding to 100% of the FOB value of the import. After 360 days, the compulsory deposit could be returned to the importer without interest or monetary correction. Excluded from this resolutions, among others, were goods imported through the Free Zone of Manaus, crude petroleum and by-products, equipment for scientific and technological research, goods from the Latin American Free Trade Association, parts and components for the manufacture of airplanes and some categories of capital goods.

c) Reduction in Governmental Imports. In 1974, through decree 74.908 the Government established a ban on direct imports of consumer goods by Governmental agencies. In 1975, through decrees 76.406 and 76.407 the Government delegated to the Economic Development Council (CDE) the establishment of limits for governmental imports. According to the Central Bank, Governmental imports represented s substantial amount of total imports. In 1977, for instance, approximately half of total Brazilian imports (US$ 12 billion) corresponded to Governmental purchases.

d) Other corrective measures. These were intended to reduce the general demand for imports in selected sectors of the economy, i.e., airplanes, computers and syderurgical, products. Regarding the computer sector, in 1975, the National Council of Foreign Trade (CONCEX) determined, through resolution 104, that all import licenses for computer equipment, parts and components would be subject to CAPRE's prior approval. Later, through resolutions 06/77 and 01/78 the Economic Development Council (CDE) fixed limits for the import of computer equipment, including parts and components for the manufacture of computers, for 1977 (US$ 100 million) and 1978 (US$ 130 million). In 1979 and 1980 the limits were raised of US$ 150 and 180 million, respectively.

Besides these import restrictions, between 1974 and 1980 the Government kept its exchange rate policy of depreciating the cruzeiro against the U.S. dollar. The crawling-peg depreciation is basically an instrument, adopted since 1968, for stimulating imports. However, it serves a dual purpose of stimulating exports and, at the same time, suppressing, to some extent, imports. Imports become increasingly expensive in terms of cruzeiros and, on the other hand, exporters are stimulated to engage in export activities.

Considering that the imports of hardware modules, parts and components for the manufacture of computers were directly affected by the import restrictions implemented by the Brazilian Government between 1974 and 1980, it seems that, in general, the corrective measures enacted by the Government limited to some extent, the flow of technological and monetary resources between the technology-supplying and recipient organizations.

TECHNOLOGICAL, INDUSTRIAL AND PHYSICAL INFRASTRUCTURE

Figures 8.28, 8.29 and 8.30 present the views of the supplier and the recipient on the extent to which, the technological, industrial and physical

SUPPLIER (——) AND RECIPIENT'S (----) PERCEPTIONS OF FACTORS AFFECTING THE TRANSFER PROCESS

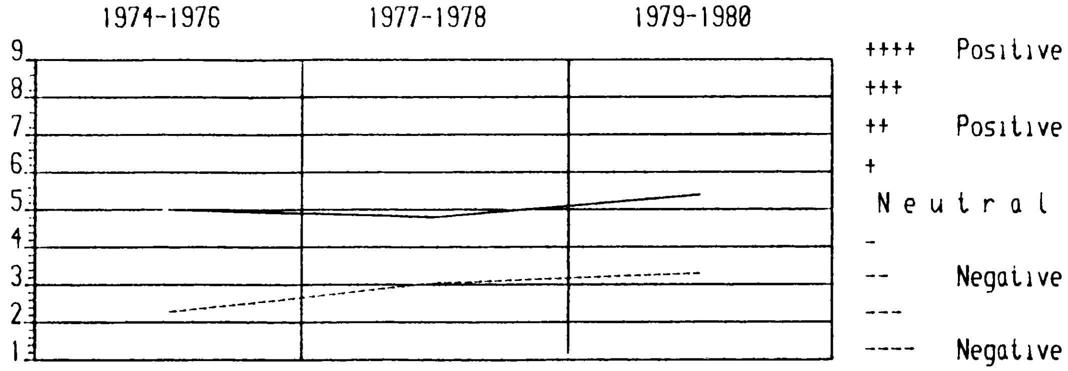

Figure **8.28** - The Technological Infrastructure

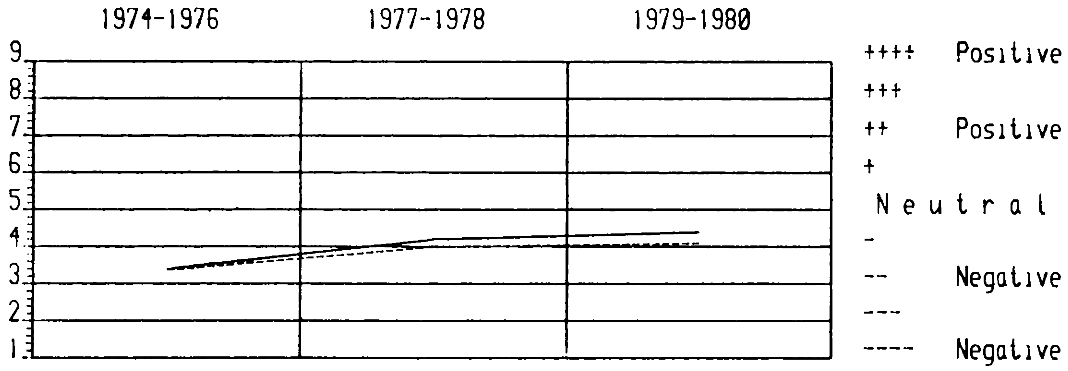

Figure **8.29** - The Industrial Infrastructure

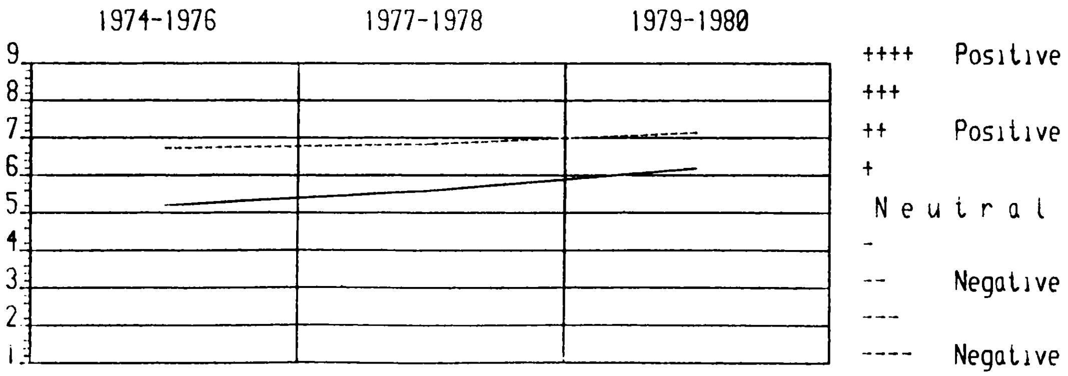

Figure **8.30** - The Physical Infrastructure

infrastructure of Brazil affected the process of transmitting resources from the technology-supplying to the recipient organization.

Regarding the technological infrastructure or the support provided by the network of universities, governmental and private research establishments, the mean scores indicate a relatively strong difference of perception in the three stages of the transfer. In general, while the supplier rated this variable as practically neutral, the recipient suggested that it was hindering the process. The influence of the technological infrastructure of the recipient country on the transfer process seems to be recognized in the literature. (Baranson, 1969; Spencer, 1970; Streeten 1972; Galbraith, 1973; Leontif, 1977; Goulet, 1977; Sobeslavsky and Beazley, 1980).

As to the industrial infrastructure of the country, both the supplier and recipient seemed to indicate that it hindered the process in the three stages of the transference. Thus, their perceptions seem to support the notion that the lack of an adequate industrial infrastructure is, sometimes, a constraint to the technology transfer process. (Baranson, 1966; 1969; 1978; Schweitzer, 1974; Halty-Carrere, 1974; Berhrman and Wallender, 1976; Well, 1980; Myrdal, 1981).

As regards the physical infrastructure of the country, an examination of the mean scores in figure 8.30 suggests that, in general, both parties considered this a favourable variable in the process. In the literature, the recipient country's physical infrastructure has been identified as a fundamental variable in the transfer process. (Baranson, 1966; 1969; Spencer and Woroniack, 1967; Stobaugh, 1969; Seurat, 1976; Fayerweather, 1969).

9. CONCLUSIONS

9. CONCLUSIONS

9.1 INTRODUCTION

The major purpose of this chapter is to draw the conclusions from the study (Section 9.2), present the limitations of the research (Section 9.3), discuss some implications of the study for managers and policy makers (Section 9.4), and suggest some areas for further research (Section 9.5).

9.2 MAJOR CONCLUSIONS

9.2.1 GENERAL

1. In the last decade, considerable attention has been dedicated to the study of technology transfer. In spite of the recent proliferation of studies focussed on the question of transferring technology internationally, most of the literature seems to be concerned with issues such as the suitability of the technology in relation to the needs of the recipient countries, the effective utilization of the technology, the impact of the technology, policies for the transference of technology, practices of multinational corporations, the price of technology, etc. In general,

there have been relatively fewer studies aimed at broader theoretical analysis of the technology transfer phenomenon.

2. Another characteristic of the literature on the international transference of technology is the general lack of agreement concerning the concepts of technology and technology transfer.

There appears to be considerable difference of opinion on what technology is. Each definition of the subject seems to reflect a different perception of the matter using a terminology associated with a particular field of activity or academic discipline.

The etymology of the word technology suggested that the term derived from the Greek concept of 'art' and the Latin notion of 'Techna'.

The concept of technology as a special category of resource seems to have been referred to by the classical economists in a variety of ways. In the eighteenth century, Adam Smith seemed to have a relatively clear understanding of the strategic and economic importance of what today would be called international technology transfer. He emphasized the "communication of knowledge", and the "useful arts" by the immigrants, giving the colonies of Europe a chance to accelerate their relative stage of development. In the nineteenth century, David Ricardo seemed to refer to technology, as a source of comparative advantage for the nations which possessed the superior knowledge, skills and machinery. Alfred Marshall also recognized the influence of technology, or knowledge, as the vital input of production.

At present, the term technology covers a wide spectrum of connotations. In a narrow sense, the concept of technology can be viewed in terms of its physical embodiments such as capital and intermediary goods, artifacts, hardware, etc. In a more general sense it can be viewed as information, computer programs, formulae, specifications, etc. In a broader sense, technology can be viewed as skills, knowledge, knowhow and abilities of human resources. The broadest views of all conceptualize technology as public knowledge, the nation's common fund of knowledge, and as basic education, combined with an attitude which favours change. In general, there is no conceptual agreement on the meaning of technology. However, the concept of technology seems to be increasingly associated with the idea of knowledge. In arriving at this conclusion we find that, the notion of knowledge, often included implicitly or explicitly in definitions of technology, seems to be a common element between old and new concepts of the matter.

Many different meanings and interpretations were found to be associated with the expression technology transfer. In general, there is no agreement of the meaning of technology transfer because there is no consensus about the meaning of technology.

3. If the concept of technology can be equated to forms of knowledge, then, the study of technology transfer seems to be concerned with the process by which individuals acquire knowledge. In this sense, the study of technology transfer appears to be intimately linked with theories of knowledge. Thus, in order to be able to fully appreciate the process of transferring technology between individuals, organizations or nations, we need to develop a better understanding of the process of knowing.

4. Perhaps, the most important contribution of this study is to provide a conceptual model for explaining the process of transferring technological resources, internationally, on an enterprise-to-enterprise basis.

The literature concerned with the theoretical aspects of the transfer process is rather restricted. There is very little known about what factors affect the process of transferring technology from one enterprise to another. Although there are some sparse contributions towards an understanding of the transfer process, no theoretical framework satisfactorily embraced the multiplicity of concepts, actors and variables involved in the transference of technological resources.

This study developed a comprehensive analysis of the technology transfer phenomenon. The multiplicity of actors and variables which may affect the transfer process were identified and integrated into a conceptual model. The technology transfer transaction was conceptualized as an exchange of interests between two parties. By exchange we mean a mutually advantageous transaction between the technology-supplying and recipient enterprises. The major actors of the process were identified as the individuals, organizations and environments of the technology-supplying and receiving countries. The interfaces of these actors, conceptualized as subsystems of the total transfer system, and their hierarchical relationships, are presented in figure 2.4, page 99. A description of the elements of the model and an outline of the logical relationships among the variables involved in the transfer process is provided in section 2.6 and presented schematically in figure 2.5, page 102.

According to the logic of the model, the flow of resources between the technology-supplying and recipient organizations is a function of the following independent variables:

a) The contractual variables, establishing the terms and conditions under which the technological resources can be transferred.

b) The individual variables, related to the characteristics and behaviour of the individuals from the technology-supplying and the recipient organizations.

c) The organizational variables, related to the characteristics and behaviour of the technology-supplying and recipient organizations.

d) The environmental variables, related to the economic, legal, political, cultural, educational and market environment of the transferring and receiving countries.

e) The technological variables, related to the nature and characteristics of the technologies involved.

f) The transmission-mechanisms variables, related to mechanisms and procedures whereby the technological resources are transmitted.

g) The time variable involved in the transmission of resources between the transferor and transferee.

In general, we have identified the major concepts, actors and variables involved in the transfer process and outlined their relationships. Considering the rather embryonic state of knowledge concerning the factors and conditions affecting the transference of technological resources, we feel that the model being proposed here will be helpful to future efforts aimed at explaining, controling or predicting the transfer process.

As a result of the present study, it may be concluded that the process of transferring technological resources internationally is a dynamic, multi- dimentional phenomenon, involving a variety of mutually interacting variables. The network of interrelationships between contractual, individual, organizational, environmental, technological, transmission-mechanisms and time-related variables can be quite complex. This suggests clearly that a number of disciplines are relevant to understanding the transfer process, and that the complete picture can only be assessed through a multi-disciplinary approach.

9.2.2 COBRA-FERRANTI

1. The creation of Cobra, in 1974 was the result of military interests, combined with a period of unprecedented growth of the Brazilian economy, government import-substitution policies, and a relatively strong "market pull" effect. Between 1968 and 1973 the Brazilian economy experienced what is often referred to as an "economic miracle". In this period, the average annual real growth rate of the Gross Domestic Product exceeded ten per cent. In the year prior to the creation of Cobra, the economy registered the best results in Brazil's history, with a surplus in the balance of trade, relatively low rates of inflation, and an annual growth of the real GDP of 14 per cent. Throughout this period, the Brazilian Government promoted industrialization via import-substitution policies, which in the early seventies emphasized imports of capital goods, intermediary inputs and the transference of advanced technologies for key sectors of the economy. Since the mid-fifties, the Brazilian Navy was planning the expansion and modernization of its fleet, which involved, among other things, the acquisition of frigates equipped with computer-based weapon control systems. In order to reduce the country's dependence

on foreign naval equipment and computer systems, for national security and economic reasons, the Brazilian Navy promoted the transference of naval defence technology to Brazil. These events, coupled with the simultaneous expansion of the installed computer base, rising demand for computers in many sectors and the extraordinary growth prospects of the minicomputer segment of the market, appear to have led the Brazilian Government to create Cobra.

2. The creation of Cobra, however, coincided with a slowdown of economic activity in Brazil. In 1974, the Brazilian economy began to reflect the problems associated with the world petroleum crisis, late in 1973. As a non-oil developing country importing approximately 80 per cent of its petroleum consumption, Brazil suffered, in subsequent years, the impact of the increases in world oil prices. Among other things, it was observed that there were relatively lower growth rates of the GDP, rising inflation rates, unprecedented deficits in the balance of trade, and a sharp rise in the foreign debt. In an attempt to control these problems, the government designed a series of monetary, fiscal and administrative corrective measures which included higher import tariffs, a compulsory deposit for imports, a reduction in Government imports, and

selective import restrictions which affected imports of computer equipment. In general, the corrective measures implemented by the Brazilian Government in response to the economic problems associated with the petroleum crisis, and the regulatory framework on technology transfer, seem to have limited, to some extent, the initial flow of technological and monetary resources between Cobra and Ferranti.

3. Regarding differences between the supplier and recipient's perceptions of factors affecting the transfer process, the overall results of the four hypotheses tested seem to indicate that, in general, although some differences of perception were found, these tended to be more accentuated in the first two stages of the process, particularly in the first. The hypotheses related with differences between the supplier and recipient perceptions of individual, technological and organizational factors affecting the transfer process were partially supported. Significant differences, however, were found between the supplier and recipient perceptions of environmental factors affecting the three stages of the transfer process. In very general terms, the findings seem to suggest that in the last stage of the process, the differences of perception tended to be relatively smaller. In other

words, although there are some differences of perception, their views regarding the factors affecting the transfer process appeared to be more nearly congruent than in the previous stages.

4. Individuals played a pivotal role in the transfer process. In very general terms, close personal relationships seemed to be more important than contractual agreements. The development of close personal relationships between individuals from the technology-supplying and recipient organizations seems to have been an important informal mechanism for the transmission of critical elements of technical knowledge. This finding lends support to the notion that individuals are the main agents in the transfer process. In spite of the initial language problems, the personal contacts, friendships and informal interactions among individuals from the two organizations appear to have exerted a critical role in the transfer process, perhaps compensating for their organizations' relative lack of experience in technology transfer transactions.

5. Since the technology-supplying and recipient organizations had no past experience in matters of technology transfer, the initial process of

transferring technological resources represented, for both organizations a learning opportunity. Following the first stage of the transfer process, the Brazilian Government formulated an industrial policy which envisaged, among other things, the acquisition of other technologies to the indigenous minicomputer segment of the market. The supplier of technology suggested that, the Brazilian experience in international technology transfer was being helpful in negotiating another licensing agreement for the manufacture of computers in a foreign nation. Thus, it appears that the Cobra-Ferranti experience in technology transfer produced, for both parties an organizational learning opportunity.

6. In a broad sense, what Cobra acquired from Ferranti was not simply "technology", elements of technical knowledge or the capacity to produce computers. In very general terms, besides technological resources, what was being transacted was a set of actual or perceived benefits in the form of the supplier's reputation and technical expertise in computers, naval defence technology, electronics, and microelectronics. In addition, other apparent benefits were the assurance of dependable supply, prospects of continuing liaison in technical matters, technical

assistance, special credit terms, etc. From the point of view of the supplier, the transaction probably meant prospects of penetrating a potentially large market, increased sales of hardware modules, electronic components and related equipment, the provision of technical assistance on a long-term basis, financial participation in Cobra, continued provision of services for the Brazilian Navy, etc. Thus, in this broad sense, the technology transfer transaction represented a mutually advantageous exchange of economic and technical interests between the technology-supplying and recipient organizations.

9.3 LIMITATIONS

In general, in the social sciences the results of any study are dependent upon those variables which the researcher chooses to include in the study. Since the researcher is often confronted with complex, multi-disciplinary problems involving a large number of variables, that it is not practical to include, the selection of the major variables seems to be an important part of the investigation. Based on the review of the literature, an attempt was made to select the most relevant factors presumed to affect the transfer process. However, in reducing reality to more manageable proportions the researcher may exclude some important variables.

Only in the recent past have systematic attempts been made to understand the actual process of transferring technology internationally. In an attempt to gain some insights into this relatively unformulated area of knowledge, among the methods of investigation this research employed a longitudinal analysis of an indepth case study. The quality of the results of case analysis depend, among other things, upon the combination of research methodologies adopted. By examining the Cobra-Ferranti experience over an extended period of time, by using our conceptual model, by utilizing the transfer process as the unit of investigation, by analyzing the matter from the supplier and recipient's angles, by comparing their perceptions with known facts, and by gathering both qualitative and quantitative information, we believe that the quality of the results derived from the case analysis improved significantly.

9.4 IMPLICATIONS

The major implications which can be drawn from this study have particular relevance to managers and policy makers concerned with matters related to the international transference of technological resources. Three main implications, regarding the individual, organizational and environmental factors in the transfer process, are summarized as follows:

a) Technology transfer is the result of a dynamic, complex process, in which individuals are the main agents. The interactions of individuals from the technology-supplying and recipient organizations play a key role in determining to some extent, the success of the transfer activities. In this respect, although there seems to be no magic formula for ensuring the development of satisfactory personal relationships, both the supplier and recipient can make an effort to create an environment conducive to personal contacts and informal relationships between individuals involved in the transference of technological resources.

b) Another important aspect of the technology transfer transaction between enterprises which have different corporate interests and objectives is the contractual agreement. It should state clearly what is being exchanged, according to mutually agreed definition of terms, chronogram of activities, and resources involved. For instance, in order to avoid future misinterpretations of the contractual agreement, in setting time limits, expressions "as soon as is reasonably practicable" should be avoided. It seems that the inclusion of such flexible time limits could lead to considerable misunderstandings if a dispute were to arise. In general terms, a clear and precise contractual agreement appears to be a necessary condition for satisfactory long-term relationships between the supplier and recipient.

c) The establishment of satisfactory individual and contractual relationships are necessary but not sufficient conditions for the transference of industrial technologies on a commercial basis. The process of transferring technological resources internationally, is limited by the interaction between the supplier and recipient's national environments. Ultimately, the flow of technological resources between two nations is dependent upon national policies and upon the regulatory framework concerning the release and acquisition of technologies. Thus, it seems important that both the supplying and recipient States should aim to establish, and periodically revise, explicit national policies relating to matters of technology transfer, in accordance with national temporary and also permanent objectives. In general, if these policies are made explicit, both the technology-supplying and recipient organizations can orient their technological transactions according to national interests, and current economic priorities.

9.5 SUGGESTIONS FOR FURTHER RESEARCH

As an exploratory study of a broad and complex subject this investigation encountered some areas with vague concepts, inadequate information and insufficient knowledge, which represent possibilities for future research. These are proposed in terms of the following questions:

What other variables exist which affect the process of transferring technological resources from one organization to another?

What is the relative importance of each variable in the transfer process?

Is it possible to measure the total effect of the transference?

What is the impact of individual, organizational and environmental characteristics upon the transfer process?

Can the impact of the transference on the economies of the supplying and recipient countries be evaluated?

This set of questions constitutes only a brief outline of the topics which can be explored in this largely underdeveloped area of research. Considering that this research was limited to the positive aspects of the transfer process, a valuable area of future research would be to include the normative aspects of the matter.

APPENDICES

APPENDIX NO. 1

THE TECHNOLOGY TRANSFER CONTRACT

1.1 AGREEMENT OF TECHNICAL INFORMATION, ASSISTANCE AND TRAINING

THIS AGREEMENT, is made the 18th day of July 1974, BETWEEN:

I - FERRANTI LIMITED a British Company having its registered office at Hollinwood, Lancashire, England, duly represented by one of its directors, Mr. A, British citizen, married, director, resident and domiciled in City X, British Passport no. (n) thereinafter referred to as "Ferranti" on the one part, and

II - COBRA - COMPUTADORES E SISTEMAS BRASILEIROS LTD (For which application has been made for registration), a Brazilian Company having its registered office at Rua Frei Fabia - no 215 - 4o. andar - parte - Engenho Novo - Rio de Janeiro - Brazil, duly represented by its directors, Mr. C and Mr. D, both Brazilians, married, engineers, residents and domicilied in City Y, (hereinafter referred to as "COBRA") on the other part.

W H E R E A S Ferranti is one of the partners of Cobra, and

W H E R E A S Cobra pursuant to its Articles of Association wishes to acquire from Ferranti certain know-how and information relating to those products designed by Ferranti and hereinafter defined, and to use such know-how and information in the manufacture and sale of such products, and

W H E R E A S Ferranti is prepared to supply such know-how and information upon the terms and conditions hereinafter set forth.

NOW IT IS HEREBY AGREED as follows:

1. As used herein the following terms shall have the following meanings:

(i) "The Products" shall mean the ARGUS 700 modules designed by Ferranti and listed in the "First Schedule" hereto.

(ii) "Technical Information" shall mean Know-how, manufacturing information, maintenance and repair information, test specifications, photographs, descriptions and other like information of a technical nature.

(iiia) "Net Selling Price" shall mean the price at which a Product manufactured or assembled and sold or repaired by Cobra, is invoiced by Cobra, less packing, transportation and insurance charges when shown separately on such invoice, all taxes incurred, and less the cost to Cobra of any parts supplied to Cobra by Ferranti and incorporated in such Product.

(iiib) In any case where Cobra deals in a Product other than by sale the Net Selling Price shall mean the price at which that Product would have been invoiced in an arms-length transaction.

(iv) "Total Sales" shall mean the sum of the Net Selling Prices of Products sold or otherwise dealt in during a stated period.

(v) "Effective Date" shall mean the date defined in Clause 17 hereof.

2. (i) Within 30 days after the date of the request by Cobra for the supply of Technical Information in respect of the ARGUS 700 T/E modules and the ARGUS 700 S modules, which request shall be made within six months after the Effective Date hereof, Ferranti shall, to the extent it is free to do so, commence supplying such Technical Information and shall complete the supply thereof as soon as is reasonably practicable

thereafter, and in any event within 180 days thereafter.

(ii) At any time within a period of two years after the Effective Date hereof Cobra may request the supply of technical Information in respect of any other ARGUS module listed in the First Schedule hereto. Within 30 days after the receipt of any such request Ferranti shall, to the extent it is free to do so, commence supplying the Technical Information in respect of the module notified in such request and shall complete the supply thereof as soon as is reasonably practicable thereafter.

(iii) Ferranti shall not be required to supply any Technical Information in respect of parts or components either (i) not designed by Ferranti, or (ii) not designed specifically for the Products. In respect of such parts or components, however, Ferranti shall provide the functional requirements and identify the source from which Ferranti obtains its supply of such parts or components.

(iv) The Technical Information supplied by Ferranti shall be all of that used by Ferranti in its manufacture of the relevant Products.

3. (i) Prior to the completion of the supply of the Technical Information pursuant to Clause 2(i) hereof Ferranti shall supply to Cobra the Standard Software Packages listed in the Second Schedule hereto and thereafter shall promptly inform COBRA of any modifications incorporated by Ferranti in such standard Software Packages.

(ii) At any time within a period of five years after the Effective Date hereof Cobra may request the supply of any other Software Package listed in the Second Schedule hereto. Within 30 days after the receipt of any such request Ferranti shall commence supplying the Software Package notified in such request and shall complete the supply thereof as soon as is reasonably practicable thereafter.

4. (i) To assist Cobra in the application of the Technical Information supplied pursuant to Clause 2(i) hereof Ferranti shall provide training for up to fifty (50) personnel of Cobra at the premises of Ferranti in England. The training will be approximately four months for each of Cobra's personnel and shall be at times agreed between Ferranti and Cobra but shall in any event be completed within a period of two years after the Effective Date hereof. The training courses will be given in the English language and Cobra's

personnel must be able to fully comprehend English and should be suitable qualified for the type of training course attended.

(ii) If Cobra requires training in England of any of its personnel in excess of the fifty (50) personnel referred to in sub-clause 4(i) and during the period of two years after the Effective Date hereof it shall so notify Ferranti and Ferranti shall provide training for such excess personnel.

5. (i) To further assist Cobra in the application of the Technical Information supplied pursuant to Clause 2(i) hereof Ferranti shall, at the request of Cobra and at times to be agreed between Ferranti and Cobra, make available to Cobra at the premises of Cobra or elsewhere in Brazil suitably qualified Ferranti engineers.

(ii) If within sixty days after Ferranti has supplied any engineer it is shown that that engineer is not suitably qualified Cobra may require Ferranti to supply a replacement engineer at no additional charge to Cobra.

6. If Cobra requires any additional assistance from Ferranti in carrying out any project involving the application of the Technical Information supplied

pursuant to Clause 2 hereof it shall so notify Ferranti. Ferranti shall inform Cobra of its charges for supplying such additional assistance and if Cobra accepts such charges Ferranti shall supply such additional assistance.

7. (i) Employees and/or Representatives of one of the parties hereto visiting the premises of the other party hereto shall be subject to all applicable rules and regulations of such other party in force at the premises being visited.

(ii) Each of the parties hereto shall be responsible for all travel, accommodation and subsistence expenses of its own personnel.

8. (i) Ferranti hereby authorizes Cobra to use the Technical Information supplied pursuant to Clause 2 hereof in the manufacture in Brazil of Products and in the sale, repair or maintenance thereof.

(ii) Ferranti hereby authorizes Cobra to copy and modify or otherwise vary the Software Packages supplied pursuant to Clause 3 hereof and to sell copies of such Software Packages, whether modified or otherwise varied or not, provided that any such sale is made in connection with a Product manufactured, sale or otherwise marketed by Cobra.

9. In consideration of the foregoing Cobra shall made the following payments to Ferranti:

(i) in respect of the supply of Technical Information relating to the ARGUS 700 T/E modules and the ARGUS 700 S modules pursuant to Clause 2(i) hereof the sum of sixty five thousand pounds Sterling (65,000) which sum shall be paid as follows:

(a) 13,000 Pounds Sterling at the time of requesting the supply of such Technical Information;

(b) 19,500 Pounds Sterling upon the completion of the supply of such Technical Information;

(c) 16,250 Pounds Sterling within one year after the completion of the supply of such Technical Information and;

(d) 16,250 Pounds Sterling within two years after the completion of the supply of such Technical Information.

(ii) in respect of the supply of Technical Information relating to any other ARGUS module listed in the First Schedule hereto pursuant to Clause 2(ii) hereof a sum in pounds Sterling equal to the list price of that module current at the time the request for the supply of that Technical Information is made (which sum, in the case of modules marked with an asterisk in the First Schedule hereto shall be reduced by a sum equal to the price of the bought-out equipments included by Ferranti in such modules) which sum shall be paid as follows:

(a) 50% at the time of making such request; and

(b) 50% upon the completion of the supply of such Technical Information

(iii) In respect of the supply of any other Software Package listed in the Second Schedule hereto pursuant to Clause 3(ii) hereof a sum in pounds Sterling equal to seven (7) times the list price of that Software Package current at the time the request for the supply of that Software Package is made which sum shall be paid upon the completion of the supply of that Software Package PROVIDED THAT if prior to making the request for the supply of that Software Package pursuant to Clause 3(ii) hereof Cobra shall have purchased that Software Package one or more times from Ferranti without the right of reproduction, the number seven (7) referred to above shall be reduced by the number of times that Cobra has so purchased that Software Package.

(iv) In respect of the training to be supplied by Ferranti pursuant to Clause 4(i) hereof the sum of one hundred and two thousand five hundred pounds Sterling (102,500) which sum shall be paid in fourteen (14) equal and successive monthly instalments, the first of such instalments to be paid 30 days after the date of request for the supply of Technical Information pursuant to Clause 2(i) hereof.

(v) In respect of any training of additional personnel of Cobra pursuant to Clause 4(ii) hereof the sum of six thousand five hundred pounds Sterling ($ 6,500) per man-year or proportionally for any part of a man-year which sum shall be paid upon the presentation of the Ferranti invoice therefor, upon the completion of the Training.

(vi) In respect of the supply of Ferranti engineers in Brazil pursuant to Clause 5 hereof the sum of thirty thousand pounds Sterling (30,000) per man-year proportionately for any part of a man-year during the first year after the Effective Date of this Agreement, which sum shall be paid upon the presentation of the Ferranti invoice therefor. This rate will be subject to review by Ferranti after the first year after the Effective Date of this Agreement.

(vii) In respect of each Product or any derivative thereof manufactured or assembled and sold by Cobra or repaired by Cobra and for which orders are accepted by Cobra prior to the expiry of a period of five (5) years after the acceptance by the customer of Cobra for the first ARGUS 700 system manufactured and sold by Cobra a levy at a maximum rate of five per cent (5%) of the Net Selling Price of that Product. Such maximum levy rate shall be decreased to a minimum rate of two per cent (2%) in accordance with the following formula:

Applicable percentage levy rate for any particular year ending on the last day of March

Levy rate = 5 / (1 + (10 (D / P)))

where P = Total Sales during that particular year in respect of which levies are being paid, and

D = Ferranti's share of the net distributed results of Cobra and/ or a proportion of the net distributed results equal to Ferranti's relative participation in Cobra's net worth not credited to any of Cobra's quota holders but put into reserve with the consent of Ferranti, for that particular year in respect of which levies are being paid. The word "distributed" means payments in cash or in additional quotas and/or shares.

10. Cobra shall keep true and particular accounts of all sums to be paid to Ferranti pursuant to Clause 9 (vii) hereof and shall within 30 days after the last days of March and September in each year during which such sums are due to be paid to Ferranti, send to Ferranti a statement showing the sums due in respect of Products delivered by Cobra during the preceding six months and shall at the same time pay to Ferranti the sums shown therein to be due PROVIDED THAT in respect of the September payment made in each year the levy rate calculated in accordance with the formula in Clause 9(vii) for the preceding year shall be used and that rate shall be corrected in the next following March, any variation in the corrected September payment being added to or subtracted from the next following March payment.

11. Cobra shall permit any representative, duly authorised by Ferranti and at the expense of Ferranti, to inspect and take copies of and extracts from the relevant accounts kept in accordance with Clause 10 hereof and will produce to such representative any receipts or vouchers relating to such accounts.

12. All sums to be paid by Cobra to Ferranti hereunder shall be paid in pounds Sterling to Ferranti at its registered office in accordance with all rules and regulations set forth by the proper Brazilian Government Authorities and after the submission of an invoice by Ferranti for the appropriate payment.

13. During the term of this Agreement each party hereto shall promptly after incorporating any improvement in Products manufactured by it inform the other party of such improvement and shall as soon as is reasonably practicable supply to such other party Technical Information relating to such improvement. The party receiving such Technical Information shall at all times have the right to incorporate such improvement in products manufactured by it and to sell such improved Products.

14. The sole liability of either party hereto with respect to the Technical Information supplied by it to the other party hereto shall be to furnish such Technical Information in accordance with the provisions of this Agreement. The party supplying such Technical Information shall have no responsibility for the ability of the receiving party to make use of such Technical Information, the quality and performance of Products produced by the receiving party or any claim

by third parties arising from the use of such Technical Information by the receiving party.

15. Each of the parties hereto shall for a period of ten years after the effective Date hereof treat as confidential all information received from the other party hereto except to the extent that such information was in the possession of the receiving party prior to the date of its receipt from the other party or to the extent that such information is or becomes published or otherwise available to the public, provided however that the receiving party may disclose such information to the extent necessary in making offers of sales, sales and otherwise marketing Products.

16. Cobra shall mark Products manufactured by it under this Agreement "Manufactured under licence from Ferranti Ltd." Cobra shall not without the prior written consent of Ferranti make any other use of the name Ferranti or any trade mark owned by Ferranti and upon termination of this Agreement for any reason, any use for which consent has been given shall forthwith cease.

17. This Agreement shall not become effective until all necessary approvals of the Brazilian Government

Authorities have been obtained. The Effective Date of this Agreement shall be the date on which Cobra notifies Ferranti of the receipt of all such approvals PROVIDED THAT if Ferranti has not received notification of the receipt of all such approvals within six months after the date of this Agreement, this Agreement shall, unless otherwise agreed between the parties hereto, be deemed never to have been entered into.

18. Subject to the provisions of Clauses 19 and 21 hereof this Agreement shall be irrevocable for a period from the Effective Date hereof until the completion of the payment of levies pursuant to Clause 9(vii) hereof.

19. Either party shall be entitled forthwith to terminate this Agreement by giving notice in writing to the other party if at any time the other party:

(i) defaults in the performance of any of the provisions of this Agreement and fails to remedy such default within 90 days after receipt of notice in writing from the other party giving details of such default or

(ii) becomes insolvent or makes any assignment for the benefit of creditors or is adjudged bankrupt or has a Receiver or Trustee appointed for the whole or any part of its assets.

20. Upon any termination of this Agreement by Ferranti pursuant to Clause 19 hereof Cobra shall make no further use of Technical Information supplied pursuant to Clause 2 hereof.

21. The provisions of Clauses 14 and 15 hereof shall survive any termination of this Agreement.

22. Termination of this Agreement pursuant to Clause 19 hereof shall be without prejudice to any claims that may have accrued to either party at the time of such termination.

23. This Agreement may not be assigned or otherwise transferred by either party hereto without the prior written consent of the party hereto.

24. Any notices to be served pursuant to this Agreement shall be sent by Registered Post, by cable or by telex to the address of the appropriate party given at the head of this Agreement or such other address as may be notified by written notice during the term of this Agreement.

25. Failure by either party hereto at any time to enforce any of the provisions of this Agreement shall not be construed as a waiver by such party of any such provision nor in any way affect the validity of this

Agreement or any part thereof.

26. This Agreement has been prepared in English and Portuguese texts. In any case of doubt the wording of the English text shall prevail.

27. All disputes arising under this Agreement which cannot be settled by Agreement between the parties hereto shall be submitted to arbitration in accordance with the rules of the International Chamber of Commerce, Paris, France.

28. All taxes, duties or stamps or any payments which might be due to the Brazilian Government, whether Federal, State or Municipal, for the signing or execution of this Agreement, or any payment resulting from these and/or in consequence upon these, excluding the withholding of the income tax on the payments to be made to Ferranti, which will be to the account of Ferranti, will be under the exclusive responsibility of Cobra.

29. Likewise, all taxes, duties or stamps or any payments which might be due to the British Government for the signing or execution of this Agreement, or any other payment resulting from these and/or in consequence upon these shall be the exclusive responsibility of Ferranti.

30. This agreement shall be binding upon the parties hereto, their successors and/or inheritors.

31. This Agreement represents the total agreement between the Parties hereto. Any changes or additions to this Agreement must be in writing and signed by the authorized representatives of the parties hereto.

32. This Agreement and the operation thereof shall be interpreted in accordance with the laws of Brazil.

33. The jurisdiction for the present Agreement is the one of the City of Rio de Janeiro, Brazil.

Therefore in witness thereof, the parties sign the present Agreement in 7 (seven) copies of equal text and form, in presence of the below mentioned witnesses

FERRANTI COBRA

Witnesses:

APPENDIX NO. 1.2

AGREEMENT OF TECHNICAL-INDUSTRIAL CO-OPERATION

THIS AMENDMENT No.1 is made the twenty third day of June 1976 BETWEEN FERRANTI LIMITED, having its registered office at Hollinwood, Lancashire, England (hereinafter referred to as "Ferranti") of the one part and Cobra - Computadores e Sistemas Brasileiros S.A., having its registered office at Largo dos Leoes No. 15, 1o. e 2o. andares, Rio de Janeiro, Brazil, (Hereinafter referred to a "Cobra") of the other part.

WHEREAS Ferranti and Cobra are parties to an Agreement of Technical Information, Assistance and Training, made the 18th day of July 1974 (hereinafter referred to as "the Assistance Agreement") registered at the Instituto Nacional da Propriedade Industrial under No. 2584/74 on the 8th day of August 1974, and registered at the Banco Central do Brasil under No. 382/523 on the 19th day of August 1974, and

WHEREAS Cobra, founded on the same day as the signature of the Assistance Agreement, is still in the phase of establishment and definition of its market, and

WHEREAS the current marketing plan of Cobra requires changes in the types of modules in respect of which Ferranti is supplying information and assistance to Cobra, which modules are listed in the First and Second Schedules of the Assistance Agreement, and

WHEREAS Ferranti is willing to change the types of modules upon the terms and conditions hereinafter set forth, and

WHEREAS Clause 31 of the Assistance Agreement provides that any changes or additions to the said Agreement must be in writing and signed by the authorised representatives of the parties to that Agreement.

NOW IT IS HEREBY AGREED as follows:

1. The following amendments to the Assistance Agreement are hereby effected:-

1.1 Delete the First and Second Schedules and substitute therefor the First and Second Schedules hereto.

1.2 In Clause 2 (i) lines 2 to 4, delete the words "and the ARGUS 700S modules, which request shall be made within six months after the Effective Date hereof", and in lines 6 and 7 delete the words "and in any event within 180 days thereafter".

1.3 In Clause 3 add a new sub clause (iii) reading as follows:

> "(iii) Notwithstanding the provisions of clause 3 (ii) hereof, within fifteen (15) days after the Effective Date of Amendment No. 1 Ferranti shall commence supplying the other Software Package PMS (Process Management System) listed in the Second Schedule hereto and shall supply all modifications and additions made by Ferranti to that Software Package during the period of two years after the date of signature of Amendment No. 1."

1.4 In Clause 4 (i), lines 6 and 7, delete the words "within a period of two years after the Effective Date hereof" and substitute therefore the words "before the 31st December 1976."

1.5 In Clause 9 (i), line 2 delete the words "and the ARGUS 700S modules".

1.6 In Clause 9 (i) delete sub-paragraphs (b) (c) and (d) and substitute therefor the following:-

> "(b) 19,500 Pounds Sterling on or before 30th June 1976"

"(c) 16,250 Pounds Sterling on or before 1st September 1976"

"(d) 16,250 Pounds Sterling on or before 1st September 1977"

1.7 In Clause 9 add a new sub-clause (vii) reading as follows:

> "(viii) Notwithstanding the provisions of Clause 9 (iii) hereof, in respect of the supply of the other Software Package PMS (Process Management System) listed in the Second Schedule hereto Cobra shall pay to Ferranti the sum of one hundred thousand pounds sterling (100,000) which sum shall be paid in eight equal successive quarterly instalments, the first of such instalments to be paid within fifteen (15) days after the Effective Date of Amendment No. 1 "

2. Ferranti has completed the supply to Cobra of Technical Information in respect of the ARGUS 700T/E modules except in respect of those modules marked with a +. Ferranti shall complete the supply to Cobra of

Technical Information in respect of those Argus 700T/E modules marked with a + within ninety (90) days after the Effective Date of this Amendment No.1.

3. If at any time within a period of 24 months after the Effective Date of this Amendment No. 1 Cobra can show to the reasonable satisfaction of Ferranti that Ferranti has omitted to supply any of the Technical Information in respect of the Argus 700T/E modules which should have been supplied pursuant to the Assistance Agreement or to this Amendment No.1, Ferranti shall promptly rectify such omission to the extent that it still has such information in its possession.

4. The Effective Date of this Amendment No. 1 shall be the date on which Cobra notifies Ferranti that this Amendment No. 1 has been registered by the Instituto Nacional da Propriedade Industrial (INPI) and by the Banco Central do Brasil.

5. This Amendment No. 1 and its operation thereof shall be interpreted in accordance with the Laws of Brazil.

6. The jurisdiction for the present Amendment No. 1 is the one of the city of Rio de Janeiro, Brazil.

Therefore in witness thereof, the parties sign the present Amendment No. 1 in 8 (eight) copies, 4 (four) in Portuguese, 4 (four) in English, in the presence of the below mentioned witnesses.

Rio de Janeiro, Brazil, 23rd of October 1976.

FERRANTI COBRA

Witnesses:

APPENDIX NO. 2

LEGISLATION ON TECHNOLOGY TRANSFER

MINISTRY OF INDUSTRY AND COMMERCE

NATIONAL INSTITUTE OF INDUSTRIAL PROPERTY (INPI)

Normative Act No. 15

The President of the INPI, exercising his attributions and in view of the provisions of article 2, sole paragraph, of Law No. 5.648 of December 11, 1970, and of article 126 of Law No. 5772 of December 21, 1971, and:

Whereas the main purpose of the INPI is to execute the norms governing industrial property, bearing in mind its social, economic, juridical and technical function;

Whereas as part of this purpose it is also competent, by law, to adopt measures to regulate and accelerate the transfer of technology, whether of foreign or domestic origin, while observing the priorities established in the national interest;

Whereas the directives established in the II PND - 2nd National Development Plan - are aimed, among other objectives, at enabling the production system to attain new levels, closely linked to the technological progress of the country:

Whereas the parameters and criteria which, intended principally to control the contracting of the transfer of technology, will also act as guidelines to the contracting parties, so that they can adapt the terms and conditions of the agreements to current legal principles, and also therefore to the Government's policy for the transfer of industrial technology and to the economic-financial policy of the country, in whole or in part;

Whereas it is necessary to enable the INPI to observe the flux in the supply and demand of technology, resolves:

I - to establish basic principles and to issue norms for the registration of agreements for the transfer of technology and related agreements, in accordance with the Industrial Property Code (Law 5.772/71).

1. - The registration of an agreement is the condition for:

a) legalizing the payments arising therefrom, whether within the country or abroad, in either case observing prevailing legal provisions and restrictions;

b) allowing, when applicable, tax deductions, observing the norms established by specific legislation;

c) giving evidence, when necessary, of the actual exploitation of the patent or the actual use of the trademark, in the country, observing the other conditions stipulated by the Industrial Property Code.

1.1 - Agreements for the transfer of technology and related agreements are classified basically according to their objects, in five categories, for the purpose of registration:

a) licence agreements for the exploitation of a patent;

b) licence agreements for the use of a trademark;

c) agreements for the supply of industrial technology;

d) agreements for technical-industrial co-operation;

e) specialized technical services agreements.

1.1.1 - The provisions which apply to each object are quite distinct, and must correspond specifically to one single agreement in the appropriate category.

1.1.2 - In the case of an agreement as

provided for in paragraph e), where the parties are resident or domiciled in the country, the agreement is only subject to registration by the INPI when the technical services are directly related to activities which are an integral part of the production system.

1.2 - If the licensor, supplier, co-operator or party rendering services controls or participates in the capital, whether directly or indirectly, the following situations will be taken into consideration, for the purposes of this Normative Act:

a) total control;

b) majority participation;

c) minority participation.

1.3 - The following are subject to registration:

a) agreements in which the parties are resident or domiciled in Brazil;

b) agreements in which the licensor, supplier of technology or supplier of specialized technical services is resident or domicilied abroad;

c) agreements in which the licensor, supplier of technology or supplier of specialized technical services is resident or domicilied in the country.

1.3.1 - In the case of agreements provided for in paragraph c), registration of the agreement is not subject to the remaining provisions of this Normative Act.

5. - Principles and basic conditions of agreement for technical-industrial co-operation.

5.1 - An agreement "for technical-industrial co-operation" is an agreement for the specific purpose of acquiring knowledge, know-how and services required for the manufacture to order of industrial units and sub-units, machines, equipment and corresponding components, and other capital goods.

5.1.1 - The agreement must include principally:

a) the supply of all the technical data, drawings and engineering specifications for the "product" and the materials used for its manufacture, as well as all the methodology of the technological development employed to obtain the same (calculation notes, etc);

b) the supply of data and information to up-date the product;

c) the rendering of technical assistance by technicians of the supplier and the training of specialized technical personnel of the recipient company.

5.1.2 - If coming from abroad, the services to be produced must:

a) correspond to levels which can not be attained or obtained in the country, which shall be verified by comparing it with actual, available national capacity to achieve the same or with already existing alternative sources;

b) bring, within the short term, real advantages for the development of the sector, in line with the objectives of national plans or policy for industrial technology and development;

c) create quality conditions for the product resulting from its application, with the additional aim of exporting the same;

d) allow the replacement of imports of the product and of the components required for its manufacture.

5.2 - Remuneration: The value of the remuneration must:

a) when directly linked to the actual manufacture of the product resulting from the application of the technology, be ascertained on a percentage basis or as a fixed amount per product unit, in either case being due on or in proportion to the net sales price, net sales receipt, or, when applicable, correlated with the profits earned by the product resulting from the application of the technology; (NOTE: For the purpose of calculating the remuneration "net price" shall mean the value of the invoicing, based on the actual sales, less the taxes, charges, components and raw materials imported either from the supplier of the technology or from any other source directly or indirectly linked to the supplier, comissions, return credits, freight, insurance and packaging expenses, as well as any other deductions which may be agreed between the contracting parties;)

b) when a fixed price, on the basis of "cost plus fixed fee", exclude any other forms of payment based on percentages of the receipt or production volume.

5.2.1 - When applicable, a fixed value may be established for the technical documentation initially supplied, which will represent an advance on the remuneration due, as established in paragraph a) of the preceding sub-item.

5.2.2 - The estimate of the total value of the remuneration of the technicians of each contracting party, must be based on the following criteria:

a) the number of technicians;

b) an individual daily rate, which must observe the criteria and standards usually adopted, including in the country of origin, assessed on the basis of the specialization and category of each technician and the nature of the services;

c) an assessment of the period judged to be sufficient for the rendering of the technical assistance and the carrying out of the personnel training programme. (NOTE: When the agreement also includes expenses connected with the maintenance of foreign technicians in the country (daily allowance, supplementary allowance and others), such expenses, which must be estimated on an individual basis, shall be paid in cruzeiros.)

5.3 - Form of Payment

5.3.1 - of paragraph a) of sub-item 5.2 - in accordance with the stipulated periods (quarterly, half-yearly or any other), through duly authenticated statements issued by the recipient company, and, when applicable, less the sum paid for the supply of the technical documentation.

5.3.2 - of paragraph b) of sub-item 5.2 - after the agreement comes into force, by means of a duly legalized invoice, specifying the services produced and the respective sum.

5.3.3 - of sub-item 5.2.1 - after the agreement comes into force, either in one lump sum or in instalments, by means of a duly legalized invoice issued by the supplier, evidencing the remittance of the technical documentation.

5.3.4 - of sub-item 5.2.2 - at the same rate as the services are actually rendered by the technicians, by means of an invoice issued by the supplier, duly itemised and legalized.

5.4 - Term - The contractual bond, which is always of a temporary nature, must establish the term considered to be necessary to enable the recipient to reach the position of being able to master the technology, by means of its actual absorption, its adequate use, and the attainment of real results derived from its incorporation, observing a period of 5 (five) years, from the actual start of production, which may be extended.

5.4.1 - In order to attain this objective, the recipient must present separate information on its technological capacity (technical-administrative infrastructure), with an explicit time-scheme for the absorption of the technology and the carrying out of the programme for training its specialized technical personnel.

5.4.2 - To this same end, and in the case of an extension being permitted, the applicable criterion shall be that of remuneration decreasing over the period, so as to allow a greater participation by engineering produced in the country.

5.4.3 - In the case of the supply of services connected with product engineering to companies manufacturing capital goods and corresponding components, and so as to further the recipient's mastery of the technology to be transferred, the services must be rendered to such companies, except if it is shown that such companies do not possess the required technical-administrative capacity, in which case the technology must be contracted by or through a national engineering and/or consulting firm, having in mind the actual absorption of the technology.

5.4.4 - The INPI reserves the right, at any time during the term of the agreement, to observe, either directly or through a duly competent authority or entity, the development of the time-scheme for the absorption of the technology and the specialized technical personnel training programme.

5.5 - Other Basic Conditions

5.5.1 - The agreement must:

a) explicitly define, and give the extent or details of, the set of data and technical information related to the technology and services to be transferred, as well as specify precisely and clearly the scope or field of activity, in the country and abroad, of the technicians who will actually render the technical assistance and carry out the programme for training specialized technicians of the recipient, aimed at the subsequent absorption of the technology;

b) identify correctly and fully the product or products, as well as the activity or industrial sector in which the technology shall be applied;

c) provide for the supply of supplementary data and technical information, linked specifically to the technology transferred and the services produced; (NOTE: If such innovations are also the object of a patent in Brazil, a specific "licence agreement" will also have to be drawn up in respect thereof, observing the conditions for agreements of this nature, except for the remuneration);

d) contain a clause to the effect that it is compulsory for the supplier, during the term of the agreement, to render technical assistance to the recipient, so as to ensure the best use of the transferred technology;

d) make suitable provision for the content of the technology to be transferred and the services to be produced, to be total, complete and adequate, so as to ensure the attainment of the established ends and the autonomy indispensable thereto;

f) include a guarantee to the effect that the supplier may not at any time claim any industrial property rights which may be connected with the contents of the technology transferred, except in respect of any details of the product or any future innovations linked to such product, provided that these are regularly protected in Brazil and in the supplier's country of residence or domicile, and that they are covered by licence agreements;

g) determine which party is liable for the payment of income tax due in Brazil;

h) define and clarify any other responsibilities and obligations, whether of the supplier or the recipient of the technology and the services.

5.5.2 - The agreement may not:

a) include either implicitly or explicitly, any reference to industrial property rights, such as "licence", "granting of licence or rights", "licensed product or process", "patented information", "industrial property rights protected against third parties", "manufactured under licence from", and others, such as are usually adopted in a 'license agreement';

(Note (1) Not withstanding the provisions of paragraph a) above, the agreement may indicate the patent held by the supplier of the technology only in its country of origin;)

(2) If the product is completed by a component or contains some element which is the object of a patent regularly filed or granted in Brazil, a royalty -free licence agreement must be signed, in accordance with

the conditions for an agreement of this kind;

b) contain a clause to the effect that it is compulsory for the recipient to assign, free of charge, the innovations, improvements or developments obtained in the country with respect to the technology transferred and the services produced, which may be transmitted to the supplier under the same conditions as those applicable to the technology transferred and the services produced;

c) provide for the performance of any other service or for any other agreement or negotiation between the parties, which is unrelated to the object of the agreement;

d) contain any clause which, implicitly or explicitly, restricts and/or prevents the supply of the technology and the services, or the activities of the recipient, which are referred to, directly or indirectly, by Law No. 5.772/71 (Industrial Property Code) and Law No. 4.137/62 (Governs repression of abuse of Economic Power), principally that which:

i) regulates, determines, alters or limits the production, sale, price, publicity or divulgation, distribution, marketing or export, as well as the hiring of personnel and the reservation or distribution of markets or the exclusion of any market, except, in the last case, when permitted by industrial property legislation, when it can be proved to be required by specific legislation of the supplier's country, or when resulting from an international act or agreement to which Brazil is a party;

ii) stipulates as a condition or obligation the purchase of raw materials or components required for the manufacture of the product, or of machines and equipment, from the supplier of the technology and/or from any other source it may determine, including domestic sources;

iii) imposes the use of a foreign trademark or publicity slogan as a condition for the supply of the technology and the services;

iv) contains provision liable to limit, control, alter, interrupt or hinder the research and technological development policy and activities of the recipient of the technology and the services;

v) is designed to prevent the recipient from contesting, whether administratively or through judicial proceedings, the industrial property rights claimed or obtained in the country by the supplier of the technology;

vi) prohibits the free use of the technology and the services when a reasonable period has elapsed after each transfer of the latest information;

vii) exempts the supplier from liability for any faults or defects inherent in the technological content of the agreement, or in respect of any actions brought by third parties for the infringement of industrial property rights.

II - Agreements in other categories, as well as other contractual conditions and terms not specifically provided for or covered by this Normative Act, shall be submitted to the prior examination of the INPI, for the necessary guidance.

III - This Normative Act will come into force on the data of its publication.

September 11th, 1975 The president of INPI

APPENDIX 3. THE INTERVIEW GUIDE

01	GENERAL INFORMATION

1

General information on the company, its organization, history, experience in technological transactions,etc.

2

Major products and markets, market share for the main products, characteristics of the market, nature of competition,etc.

0 2 GENERAL INFORMATION

1 Ownership of the company and major changes in the capital structure.

2 The evolution of the company, in terms of number of employees, sales, financial indicators, etc.

0 3 FACTORS AFFECTING THE TRANSFER PROCESS

Please describe the major factors affecting positively (facilitating, helping) the transmission of technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979-1980) stages of the transfer process.

1

2

3

04	FACTORS AFFECTING THE TRANSFER PROCESS

Please describe the major factors affecting negatively (inhibiting , impeding) the transmission of technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979-1980) stages of the transfer process.

1

2

3

0 5	FACTORS AFFECTING THE TRANSFER PROC[illegible]

Please indicate the extent to which the following factors had [illegible]e, neutral or negative effect on the process of transferring techn[illegible], at the initial (1974-1976), intermediary (1977-1978), and curr[illegible] -1980) stages of the transference.

				N					
— ☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9 +	

	Factor	1	2	3	4	5	6	7	8	9
1	The educational background of the individuals acquiring the technology.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
2	The training levels of the individuals in computer technology.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
3	The professional experience in industrial activities of the recipients.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
4	The technological complexity of the product and its components.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐
5	The technological complexity of the processes used to produce computers.	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐	☐ ☐ ☐

0 6 FACTORS AFFECTING THE TRANSFER PROCESS

Please indicate the extent to which the following factors had a positive, neutral or negative effect on the process of transferring technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979 -1980) stages of the transference.

					N					
	☐	☐	☐	☐	☐	☐	☐	☐	☐	
—	1	2	3	4	5	6	7	8	9	+

		1	2	3	4	5	6	7	8	9
1	The degree of ownership by the transferor of the recipient's capital structure.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
2	The availability of management resources in the recipient organization.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
3	The availability of engineering and technical resources in the recipient organization.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
4	The availability of other human resources in the recipient organization.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
5	The availability of parts, components and other material resources for production.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐

0 7 FACTORS AFFECTING THE TRANSFER PROCESS

Please indicate the extent to which the following factors had a positive, neutral or negative effect on the process of transferring technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979 -1980) stages of the transference.

				N					
— 1	2	3	4	5	6	7	8	9 +	

1 The general collective ideology of the nation.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7 8 9

2 The general attitude toward foreigners.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7 8 9

3 The availability of schools, universities , etc, providing formal education.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7 8 9

4 The availability of training institutions, providing specialized courses, etc.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7 8 9

5 The general political climate in the recipient country.

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
1 2 3 4 5 6 7 8 9

0 8 FACTORS AFFECTING THE TRANSFER PROCESS

Please indicate the extent to which the following factors had a positive, neutral or negative effect on the process of transferring technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979 -1980) stages of the transference.

					N					
—	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9	+

1 The set of laws, regulations and administrative controls on technological transactions.	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9
2 The exchange control regulations.	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9
3 The import regulations, tariffs, import duties, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9
4 The legal and administrative controls on remittance of profits and royalties abroad.	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9
5 The overall state of the economy as reflected by production levels, inflation, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐	☐	☐	☐	☐
	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7	☐ 8	☐ 9

0 9 FACTORS AFFECTING THE TRANSFER PROCESS

Please indicate the extent to which the following factors had a positive, neutral or negative effect on the process of transferring technology, at the initial (1974-1976), intermediary (1977-1978), and current (1979 -1980) stages of the transference.

				N					
	☐	☐	☐	☐	☐	☐	☐	☐	☐
−	1	2	3	4	5	6	7	8	9	+

		1	2	3	4	5	6	7	8	9
1	The general state of the balance of payments.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
2	The general state of the market, level of demand, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
3	The availability of suppliers and other companies providing support for the recipient.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
4	The availability of transportation, communication systems, energy, etc.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
5	The availability of universities , research institutions, etc, providing technological support for industrial enterprises.	☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐
		☐	☐	☐	☐	☐	☐	☐	☐	☐

APPENDIX 4

OPERATIONAL DEFINITIONS

This appendix intends to provide operational definitions of the variables gathered through personal interviews, and a description of the methods of measurement and scales employed. Most variables described here were measured in relation to three periods of time, or the initial (T1 : 1974 - 1976), intermediary (T2 : 1977 - 1978), and current (T3: 1979 - 1980) stages of the transfer process.

INFORMATION ON THE ORGANIZATION

These items were designed as a guide for collecting general information on the technology-supplying and recipient organizations. Among these items were information on the organization of the company, general history of the organization, experience in technological transactions, principal products and markets, approximate market share for the major products, general characteristics of the market, information on the ownership of the company and subsequent changes in the capital structure, general evolution of the company in terms of number of employees, assets, equity, sales, etc. (Questionnaire items 01 and 02).

FACTORS AFFECTING THE TRANSFER PROCESS

Seven questionnaire items were utilized for assessing the supplier and recipient's perceptions of factors influencing positively, neutrally or negatively the transference of technological resources. Questionnaire items 03 and 04 were designed to gather qualitative information, while questionnaire items from 05 to 09 employed a nine-point semantic differential scale (Osgood et al., 1957) varying from negative to positive.

QUALITATIVE ITEMS. Subjects were asked to describe the major factors facilitating (Questionnaire item 03) and inhibiting (Questionnaire item 04) the transfer process, at the initial, intermediary and current stages of transference.

QUANTITATIVE ITEMS. Subjects were asked to rate fifteen variables presumed to have a positive, neutral or positive influence in the transfer process, at each stage of the transference. (Questionnaire items 05, 06, 07, 08, and 09).

The individual, technological and

organizational variables were derived from the general management literature, while those related to the macro-environment were selected from Farmer and Richman's (1966) comparative management matrix and adapted for the purposes of this research. The following variables were included:

INDIVIDUAL VARIABLES (IND)

Individuals' Education. Refers to the educational background of the individuals acquiring the technology.

Individuals' training. Refers to the individuals' levels of training in computer technology, (computer science, computer engineering and/or computer usage technology).

Individuals' Experience. Refers to the professional experience in industrial activities of the recipients.

TECHNOLOGICAL VARIABLES (TEC)

Product Complexity. Refers to the level of technological complexity of the product and its components, i.e. hardware modules, printed circuit boards, etc.

Process Complexity. Refers to the level of technological complexity of the process used to manufacture computers, i.e. assembling procedures, testing procedures, etc.

ORGANIZATIONAL VARIABLES (ORG)

Degree of Ownership. Refers to the degree of ownership by the transferor of the recipient's capital structure.

Management Resources. Refers to the availability of management resources in the recipient organization.

Engineering and Technical Resources. Refers to the availability of engineering and technical manpower in the recipient organization.

Other Human Resources. Refers to the availability of skilled, semi-skilled and other human resources in the recipient organization.

Local Inputs. Refers to the availability of parts, components and other material resources needed for production, from local suppliers.

MACRO-ENVIRONMENTAL VARIABLES (ENV)

National Ideology. Refers to the general collective ideology of the nation as exemplified by writing, speaking and other manifestations of a national point of view.

View Toward Foreigners. Refers to the general attitude towards foreigners as evidenced by overt behaviour.

The Formal Educational Infrastructure. Refers to the availability of schools, universities and similar institutions providing formal education for the labour market.

The Informal Educational Infrastructure. Refers to the availability of training establishments providing specialized training courses, up-grading human resources, etc.

Political Climate. Refers to the general political climate in the recipient country.

Technology Transfer Regulations. Refer to the set of rules, laws, decrees and administrative controls on technology transfer transactions in general.

Exchange Control Regulations. Refer to the legal and administrative controls on the conversion of local currency to foreign currencies.

Import Regulations. Refer to the set of rules controlling imports including tariffs, quotas, import restrictions, etc.

Royalty and Profit Remission Regulations. Refer to the legal and administrative controls on remittance of profits and royalties to foreign countries.

Economic Conjuncture. Refers to the overall state of the economy as reflected by short-term indicators such as industrial production levels, inflation patterns, the financial and capital markets, etc.

General Balance of Payments Position. Refers to the general state of the Balance of Payments, surpluses or deficits in the balance of trade, current and capital account, etc.

The Market Environment. Refers to the general state of the market, i.e. its characteristics, level of demand, etc.

The Industrial Infrastructure. Refers to the availability of suppliers, companies within and outside the computer industry, providing support, service, external economies, etc.

Physical Infrastructure. Refers to the availability of power supplies, water, communication systems, transportation, etc.

Technological Infrastructure. Refers to the availability of universities, governmental and private research institutions and other organizations providing technological support for industrial enterprises.

SUMMARY MEASURES

In order to test the hypotheses, summary measures of individual, technological, organizational and environmental factors were created for each stage of the process, for both the supplying and recipient groups. These summary measures consisted of the mean scores of the variables comprising each factor. They represented an index of the extent to which, a particular group perceived, at each stage of the process, the set of factors exerting a negative, neutral or positive influence on the transfer process. The following notation was adopted for the summary measures:

XXXN, where

XXX Refers to the individual (IND), technological (TEC), organizational (ORG) or environmental (ENV) factors.

N Refers to the Initial (1), intermediary (2) or current (3) stages of the transfer process.

Thus, 'ORG2' refers to the summary measure of organizational factors at the intermediary stage of the process.

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